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DE LESSEPS IN 1893.

FERDINAND DE LESSEPS.

If Ferdinand de Lesseps erred, it was as an excessive optimist; "but the world belongs to optimists." Such were the words of M. Barboux, uttered in Paris on January 25, in defense of Ferdinand de Lesseps in the charges brought against him in connection with the Panama Canal. Some two weeks later De Lesseps, once the glory of France, was sentenced for bribery and corruption in connection with the Panama Canal to five years' imprisonment and 3,000 francs fine. The millions of France spent upon the Isthmus of Panama are virtually a total loss, the work is abandoned, and it seems questionable if the isthmus will ever be penetrated, at that point at least.

We publish several portraits of the great promoter, and in connection therewith some details of his long life, now rapidly drawing to a close, and closing so sadly, will be of interest. He was born at Versailles in 1805, and early entered the consular service of his country. He served as consul in Egypt and Barcelona, as special envoy to Rome, and as long ago as 1854 may be said to have terminated what for most men would be a full diplomatic career. Among his early consular positions was that of Egypt in the time of Mehemet Ali, from 1836 to 1840. Some forty years ago he had earned a retiring pension on the French civil list. After this his great work was to begin. In 1854 he was invited by Said Pasha to visit Cairo. During this visit he is said to have conceived the plan of carrying out the old idea of Napoleon I., the piercing of the Isthmus of Suez. Eighteen months later he published a monograph on the subject and then began his work. In England he could do nothing in the way of raising capital. The political authorities of England opposed him, both at home and in Constantinople, but in France encouragement was received.

De Lesseps was a relative of the Empress; this gave him prestige and influence, and Napoleon III. was always interested in work of this sort. The Mediterranean states also subscribed, and the original Suez Canal Co. was formed with a capital of 8,000,000 pounds sterling. After an expenditure of 17,000,000 pounds sterling, the canal was finished. On November 17, 1869, the opening ceremony took place. On the 25th day of the same month he married Mlle. Helene Autard de Bragard, a Creole lady, his second wife. One of our pictures presenting him at 83 years of age, surrounded by his family, shows the results of this marriage. At 73 years of age he is described as a delightful host, full of life and energy, exhibiting with pride his six year old twins in his nursery, showing the trophies received in honor of his great achievements, and his ribbon of the Legion of Honor, which he had then worn for forty years.

In 1878 he visited the Isthmus of Panama, to determine the practicability of a canal. Many years previously he had been there as consul, at the time in the thirties when Humboldt was advocating such a work. It is thought that he may even at that early time have conceived the idea of carrying out the enterprise. He returned to France, pronounced the canal practicable, the company was organized, the engineers left Paris for the isthmus on Jan. 3, 1881, and on Feb. 24 the work began. To-day it is abandoned and in ruins.

His great physical powers at this time have often been descanted on. He was a great rider. It was said that he could even at his advanced age mount a galloping horse. Other stories are told which picture him as a rival in some sense to Chevreul, the centenarian scientist. Now all is changed. Nearly 90 years old, we see him sitting in his library at his retired country home, the chateau of La Chesnaye. The photographer who took his last portrait found him with his legs wrapped in a blanket, in an almost lethargic state, from which he could be aroused but for a few minutes. When informed that his photograph was to be taken, he tried to shake off the torpor, and turned smilingly toward the instrument. All at once sleep overtakes him, and he is photographed as we show him. He is again awakened to receive the thanks of the photographer, and leaning on his cane is supported by his son to the table. It is presumed that he will die in ignorance of the fate which has befallen him, and his wife, who has sustained him with all the energy of the Creole nature, and his family, shown so beautifully in the group, will be those most affected by the sentence of the French court.

It is far from easy to express in figures the revelations of the Panama Canal investigation. Bribery of government officials and of newspapers was carried on wholesale. The original estimate of cost of the canal was $120,000,000. It now has run up a liability exceeding $450,000,000. M. Flory, accountant for the French government, has within a few weeks handed in a report which in round numbers states that the contractors received $90,000,000 (462,620,064 f.), and that for labor there was paid out $20,000,000 (102,358,444 f.), giving a total of $110,000,000. This shows an unaccounted for or disgracefully accounted for balance of several hundred millions of dollars. In other words, for liabilities of $450,000,000, expenditures of less than one-third the amount can be shown.

France apologizes for the faults of her heroes. However moral in principle, the ardent Frenchman overlooks the failings of Napoleon the First. De Lesseps has impoverished the people of the republic far and wide. When in need of subscriptions to the Panama Canal, he used to say that the woolen stockings would supply it. He alluded to the savings of the economical peasants, who preserve their money in these receptacles. In carrying through the construction of the Suez Canal, he was declared to have done enough "to make one reign illustrious." He was named the "Duke of Suez," as a sort of popular title of nobility *in partibus.*

Now shorn of his honors, dependent for a peaceful death on the indulgence of France, with ignorance his only bliss, with the control of the Suez Canal in England's hands, he awaits death. His last work a complete failure, carried on to the point of failure by bribery and corruption, may be said to be enough to make the new republic very much the reverse of illustrious.

Some of the English pumping engines perform work equaling the raising of 120,000,000 pounds one foot high by the consumption of one hundredweight of coal.

THE GUN TRIALS OF THE TWIN-SCREW ARMOR-CLAD RAM LIBERTAD.

This remarkable vessel was designed and built for the Argentine navy by Messrs. Laird Bros. We now describe the armament and the trials which have just been concluded. In the Libertad the generally accepted principle of supplementing the main armament by a secondary one has been fully carried out. The main armament consists of two 24 cm. breech-loading Krupp guns, mounted in two barbettes, and the secondary one comprises four 4·7 in. Armstrong breech-loading, quick-fire guns, mounted in sponsons amidships, two on each side; four three-pounder Maxim-Nordenfelts, mounted on the superstructure; two 1 in. three-barrel Maxim-Nordenfelts, also on the superstructure amidships, one on each side; and two machine guns in the top. On the armored deck, just abaft the forward barbette, are two 18 in. Whitehead torpedo ejectors. Taking these weapons in order, the two Krupp guns have the well known sliding wedge breech mechanism. But the shields, carriages and working arrangements are of the Elswick pattern, and manufactured by Sir W. G. Armstrong, Mitchell & Co., and represent the latest and most approved system, the principal advantages being extreme facility in handling and working, great elevation, whereby the maximum range of the gun can be utilized, and very substantial protection to the gun's crew. Each gun is mounted upon a carriage fixed to a revolving base plate, which also carries the shield. This base plate is supported by a ring of live rollers, which run in a circular path upon the top of the annular structure inside the barbette. The gun, carriage and shield are rotated by a hand gear situated within the barbette on the armored deck. The recoil of the gun is taken up by the usual hydraulic buffers, but as the sides are horizontal, the gun is returned to the firing position by means of two powerful helical springs, which are compressed during recoil. In order to lessen the frictional resistance of the gun, the trunnions are fitted with the very ingenious Elswick knife-edge arrangement; as there is but little, if any, preponderance, the gun can be elevated or depressed with the least possible exertion, notwithstanding that the weight to be moved is nearly 22 tons.

The gun is inclosed by an elliptic shield or turret, composed of steel armor 6 in. thick on the vertical portions and 4 in. thick on the slopes. The gun port is through the sloping portion, and this allows of very great elevation being given with the minimum of port area. The trunnions for this purpose are just within the port. The adoption of horizontal slides not only renders a very small port possible for high-angle fire, but also prevents a heavy blow being given to the ship's structure. Within each shield, on the right-hand side of the gun, are the sighting and elevating mechanism, voice tubes, telegraphs, and pneumatic rammer; the air cylinders for the latter being conveniently placed between the sides of the carriage. This pneumatic rammer is an alternative to hand ramming. On the left-hand side of the gun is the small hand winch for raising the projectiles into the breech. In this connection the Elswick firm has introduced a novel and most convenient arrangement. Instead of stowing the projectiles in fixed racks, there is a circular revolving rack just below the floor of the turret. In this rack 32 projectiles are arranged with their axes tangentially. By lifting a hinged door and turning the rack, a projectile is brought immediately to the breech of the gun, to which it is lifted by the winch.

In the center of the barbette is the powder tube, closed by a flap. In this new mounting all the operations connected with the loading and working of the gun are performed entirely by manual labor. The full gun's crew consists of six men only, but one man can work the gun with ease, if not with rapidity. This vessel is the first that has been equipped with mountings for heavy guns allowing for high-angle fire. This is a most valuable feature, and one that, under not improbable circumstances, might play a most important part in the bombardment of a naval port.

Protected barbette mountings for high-angle fire were brought forward by the Elswick Company in 1889, and during the spring of 1890 a mounting for a 9·2 in. gun was exhaustively experimented with at Portsmouth, on board H.M.S. Hardy, with very satisfactory results, the gun having been fired with its maximum charge of 160 lb. at an elevation of 30½ deg. and with a reduced charge at 40 deg. In the Libertad each of the heavy guns trains through an arc of 260 deg., and has a vertical range of 45 deg., viz., 5 deg. depression and 40 deg. elevation. Below are the principal data connected with them:

Caliber	9·4 or 24 cm.
Weight of gun	21·6 tons.
Weight of full charge	187 lb.
Weight of projectile	352 lb.
Muzzle velocity	2,133 ft. per sec.
Muzzle energy	11,105 foot tons.
Perforation of wrought iron at muzzle	19·8 in.
Number of rounds carried	80 per gun.

As regards the guns composing the secondary armament, little need be said about them, as they are too well known to need a lengthy description. The 4·7 in. or 12 cm. breech-loading quick-fire gun is, perhaps, the most favorite weapon in the navies of the world, and it, or a similar type, is found in nearly every warship of recent construction. The guns in the Libertad have the new Elswick electric and percussion firing arrangements. For convenient reference the following table will be useful:

Caliber	4·7 in. or 12 cm.
Length in calibers	41
Weight of gun	2·1 tons.
Weight of carriage and shield	3·4 tons
Weight of charge	5·64 lb. (cordite).
Weight of projectile	45 lb.
Muzzle velocity	2,230 ft. per sec.
Muzzle energy	1,572 foot tons.
Perforation of wrought iron at muzzle	10·65 in.
Rounds per minute	10

Bearing in mind the small displacement of the Libertad, it will be gathered that she is very heavily armed. To enable her to carry such an armament, and to use it effectively, called forth no little skill on the part of her designers. It is, perhaps, the first time that such a powerful armament has been placed in so small a vessel, accompanied as it is with such thorough protection. The problem, however, of providing the necessary structural strength without an excess of weight has been well worked out. We may add that the armor of the Libertad was the subject of very exhaustive firing experiments in 1890.

The gun trials were recently carried out in Liverpool Bay by Captain Barilari and the officers and crew of the ship, in the presence of the officers of the Argentine Naval Commission, including Admiral Howard, Chief of the Commission; Captain Loqui; Mr. Hughes, Engineer-in-Chief; Captain Lira, of the sister ship Independencia; Captain Dufaurg; Captain Penar; Lieutenant Pozzo, and the principal officers of the battle ship Almirante Brown, and Captain Selstrom, of the Nine de Julio. The builders were represented by Mr. Henry Laird and several of Messrs. Laird's principal officers. The Elswick firm was represented by Captain Harvey, R.N.; Commander Lloyd, R.N., and the well known gunnery expert Mr. J. Vavaseur. Among others present were the naval attaches of the French, Italian, and United States Legations, Professor Biles, of Glasgow University, Mr. G. N. Little, of Liverpool, etc.

The weather was very suitable for the purpose, there being a moderate breeze, a slight swell, and a good light. The programme provided for firing the forward 24 cm. gun was as follows: Starboard beam, horizontal; 45° before the beam, horizontal; port beam, 15° elevation. After 24 cm. gun, 40° before starboard beam, horizontal; 45° abaft starboard beam, horizontal; port beam, 25° elevation. The 4·7 in. or 12 cm. guns were fired right fore and aft, and on each beam horizontal, each beam at maximum angle of depression, each beam at 15° elevation.

The 47 mm. guns and the 25 mm. guns were fired at 7½° elevation, horizontal, and at angles of maximum depression. Finally, broadsides were to be fired simultaneously and separately. Full service charges were used for all guns throughout the trials. For the 24 cm. guns this consisted of 86 kilos. of brown prismatic powder, and the projectiles—common shells—weighed 100 kilos. each. For the 12 cm. guns Chilworth smokeless powder was employed.

The trials were well calculated to severely test the mountings and structure of the ship, yet after the trials a very close survey failed to reveal any sign of strain of weakness anywhere. The only effect of the heavy discharges was to smash the glass of the windows of the chart house, and when the after 24 cm. gun was fired at 40° before the port beam, an iron door on the after part of the superstructure was nearly wrenched off and deposited on the deck. Beyond this there was absolutely no sign of any damage. This is the more remarkable considering that the axes of the heavy guns are only 5 ft. above the deck. At the conclusion of the trials the naval commission expressed their satisfaction with the vessel.

The Libertad has since sailed for South America.—*The Engineer.*

THE PASADENA AND MOUNT WILSON RAILWAY.

Seven miles to the east of Los Angeles, the metropolis of southern California, is the beautiful little city of Pasadena, and two miles further on the valley is lifted in the air on the rapidly rising foot hills of the Sierra Madre mountains. Of this historic range one peak towers above the rest like a mighty sentinel. It is Mount Wilson, whose bold, majestic apex rises 6,000 feet above the blue waters of the Pacific, only a few miles distant. This eminence has long been one of the most favored resorts, but the means of reaching it were so arduous that, of those whose health a brief sojourn at the peak would most benefit, few have felt able to endure the danger and hardships of the journey. Notwithstanding the difficulties, 4,000 visitors annually have traveled the two narrow trails which lead to the resort hotel, a veritable mecca, at the top.

The only transportation was by burros, or "Rocky Mountain canaries," as they are affectionally called a little further east.

The road starts with a trolley system at Alledena, a quiet little village at the foot of the mountains, and there connects with the Los Angeles Terminal Railroad. Nothing unusual in construction appears here. For the first two miles a gradual grade of 7 per cent. is encountered, bringing the visitor to the Rubio Canyon, a rugged mountain gorge. Here the road is confronted by a bold, cone-shaped mountain, like a huge inverted sugar bowl. Here also the character of the road changes from trolley to cable system, but without change of cars here or at any other point on the line. Thus far the route has been a single track, T rail construction, with the ordinary overhead wiring. The cable section, however, is double tracked and continues so to the summit of the cone, called "Echo Mountain." The average grade is 60 per cent. and the car speed on this portion of the road is only four miles an hour, which, however, is quite enough for many people, to whom the six minutes consumed in making the ascent seems as many hours. The length of this section is 2,600 feet, with a vertical rise of 1,600 feet, making it the steepest railway in the world; the Mt. Pilatus rack road in Switzerland being next in order, with a grade of 48 per cent. The car is raised by an endless cable, which passes around a horizontal terminal sheave at the bottom, which is carried on a weighted frame, and serves, also, the additional purpose of tension carriage. Two steel cables are employed—a traction rope 1¼ inches and a safety rope 1½ inches in diameter. The grip for traction cable is placed beneath the front platform and the safety grip under the middle of the car. The moment the traction rope is released the safety grip instantly closes on the other rope, making descent impossible. At the top the traction rope is wound three times around a driving drum. This drum is geared to an electric motor, and here the cable, overhead wire and storage systems are united in a remarkable unity. At this station are 300 storage cells, and they play an important part. The car motor and the motor which drives the cable are shunt wound; both may be converted into generators at will, and when the car descends the incline or

a grade, serve the double purpose of a brake and economy of otherwise wasted power. This energy, which is usually lost, is here carefully husbanded. The moment the car motor ceases to require energy, the conditions are reversed, and gravity is made to give back a part of the price paid in ascending. Having brought our electric cable car safely to the summit, let the reader now go back a little and seek the advantage and necessity of the storage batteries. As already mentioned, falling water is the initial power. On the line of the road is a mountain stream which never freezes and which has an undiminished flow throughout the year. It gathers its sparkling waters from melting snows and living springs on the topmost heights, and has a descent gradual in places and precipitous in others. It follows, however, a nearly straight line from summit to base of the mountain, where it is cut up and distributed through the many irrigating systems which mark the valley everywhere with their miles upon miles of narrow ditches. Vested rights of the people below made it impossible to divert the stream or store it in a reservoir; hence it was decided to flume it from a place far up on the mountain, through steel pipes.

Although the volume of water is quite small, the vertical descent of 1,400 feet affords a pressure of 600 pounds to the square inch as it emerges through a half inch orifice, impinging itself in an undershot stream against the buckets of a tangential wheel. So great is the force of the escaping water, one cannot cut it with the stroke of an ax, which, instead of cutting through the stream, is thrown violently from the hands. At present but one of these wheels is in operation, but two more will be added, making in all three such stations on the line, at altitudes of 1,400 feet apart. The shaft of each wheel is coupled direct to a generator, and the water from the first wheel is piped to the second and discharging there to the third, where it escapes into the natural bed of the stream. As the wheels and generators are expected to operate continuously during the 24 hours, the supply of water for irrigation is unaffected. Should, however, the wheels be stopped, the water would again follow its own natural channel through the rocks, cut centuries ago. While these water wheels and generators are placed at altitudes about 1,400 feet apart, the distance between any two is several miles, and no one wheel and generator exerts force enough in itself to meet the requirements for operating its own section of road. Hence storage batteries are employed as reserve reservoirs of power, not only at the station from which the cable is driven, but at intervals along the whole line. As the necessities of travel are met with only two continuous working hours per day, it will be seen there are 22 hours in which to store the batteries, during which time no other demand is made on the generators. Should any ordinary accident disable even all three generators, it is expected the batteries would still be sufficient to operate the system the necessary two hours, or one working day. In case the batteries became wholly exhausted, the full 24 hours would be required to again fully recharge them.

Turning our attention again to the cable division of the road, we find some very interesting calculations in transmission and retransmission of electrical power, which have been worked out by A. W. Decker, the electrical engineer, who has had immediate charge of this branch of the construction. According to his calculations, 15 horse power is required to operate the cable and raise one empty car when counterbalanced

DE LESSEPS IN 1883.

by the gravity power of the other empty car in its descent. Hence, under the present arrangement of driving machinery, one car must always take the descending cable in order to raise the ascending car. Should, however, the ascending car carry its full load of 24 passengers, an additional 30 horse power is necessary, requiring a total output of 45 horse power to raise a loaded car against one empty. If, however, the ascending car be empty and the descending car loaded, the conditions would reverse, and instead of drawing from the batteries, the loaded car would not only establish the equilibrium but would in addition move the cable and return 15 horse power to the batteries. This principle of return power will prevail over the whole line, so that Mr. Decker estimates the power given back by the cars moving down grade will equal fully 40 per cent. of the total amount required to operate the system.

As to the construction of the road itself, it is surprisingly free from deep cuts and trestles. In an air line from the mountain top terminus to the base of the range the distance is about 4¼ miles. The road, however, after leaving the top of the incline at Echo Mountain, follows a serpentine route by easy though almost continuous grades to the summit, traversing the distance of 10 miles. The grades average only 7·5 per cent. and the curves are in no case less than 80 feet radius. The line is single track with occasional turnouts, with the exception of the 2,600 feet of double track cable at the incline.

The scenery presented while making the ascent has been pronounced as unsurpassed by travelers who have been in all parts of the world. Many distinguished men have journeyed to the summit. Only recently President Eliot, of Harvard, made the trip and selected a site for the great astronomical photographic lens, of which so much is expected. He pronounced the view as unequaled by any he had ever seen. The great valley for 60 miles stretches out before the vision like a vast garden, the orange groves and vineyards dotted here and there by villages, from which steeples rise as if to catch the eye; while as a border on the west, sky and ocean meet in a rim of rich blue, tinged silvery in the center by the sun, and bending like a crescent to frame half the picture. To the south the rocky ribs of the San Jacinto range are lost in the blue haze of the horizon.

On Echo Mountain, below the line of winter snow, the air is soft and pleasantly, uniformly cool, freed from the languorous warmth of the valley. It comes floating in gentle waves with the odor of orange blossoms and the sweet perfume of rose gardens, of eucalyptus and almond, and a thousand different flowers. Turning and looking toward the summit is presented the wildest mountain scenery, in strange and striking contrast to the peaceful picture of the valley below. The path of the road here and there in serpentine form presents a continuous panorama of succeeding wild and thrilling scenes, shutting from the sight of the passengers a harmonious view of green orange orchards and rose gardens. The route plunges across a saddle dividing two canyons flanked on one side by a solid wall of granite extending fifteen hundred feet below, and as many above, and upon the other by a thickly wooded slope almost as precipitous.

There is no perpetual snow in the higher altitudes of these mountains, though it lies on them during the four winter months, at times to a depth of six feet. In these altitudes the air is cold, light, dry and stimulating, and its invigorating influence is at once felt. It is somewhat rarefied and of phenomenal clearness. It is remarkable that the alternating red, white, and blue flash lights of the lighthouse on the island of South Catalina in the Pacific Ocean, 60 miles distant, can be seen with perfect distinctness. This point, the terminus on Wilson's Peak, will be reached in one hour after leaving Alledena.

In the scheme of the railroad is included the erection

DE LESSEPS AND HIS FAMILY IN 1888.

of two elaborate hotels. The first is now under way on the top of Echo Mountain, and will be an all-the-year-around house. This altitude is above the fog and below the snow line, and will be especially patronized by persons suffering from pulmonary and bronchial affections.

The second hotel will be built on Mt. Wilson, and will probably not be in operation during the winter months, though this will be determined later on. Besides the Harvard station on this mountain, there will also be the astronomical observatory of the University of Southern California, that will erect a lens surpassing in size that of the Lick telescope.

The total cost of the completed road and the hotels is placed at $600,000. The construction of the first section and the first hotel is being paid for by the proprietor himself, without having placed a security upon the market. The remaining portion of the road will be built with money raised from the sale of bonds. It is estimated that the annual revenues of this road will be that of about 60,000 fares, though 20,000 will pay expenses and allow a good interest on the investment. This calculation is not prodigal when it is considered that the road will certainly constitute one of the special features patronized by tourists to Southern California, and that this tourist travel now amounts to 100,000 yearly. The income derived from this source is separate from that to be yielded by the adjacent resident population, which amounts to 200,000 of the most active, and many of them the most cultured citizens in the land.

This article would be incomplete without a mention of the man who is the soul of the enterprise, Prof. T. S. C. Lowe, who has not only planned the technicalities of the road and fathered the project, but has wholly assumed the undertaking financially.

Prof. Lowe is now past his sixtieth year, and culminates a lifetime of successful exploits with this mountain railway. He has successively been an inventor of mechanical devices and chemical compounds.

Prof. Lowe came into public distinction first as the originator of balloon service for military observation, aiding Gen. McClellan during the civil war, which fact may partly account for his ambition to run a railway as nearly straight into the air as possible. He came to California a few years ago, leaving paying business relations in the East. Since his coming to Pasadena his ever-active mind has brought about the building of his own beautiful residence, the establishment of public gas works and an artificial ice factory, besides owning several buildings and holding positions of financial trust.

Prof. Lowe is, without doubt, one of the foremost factors in the progress of Southern California, and if a man's age is to be counted by activity, we must set down his years at thirty instead of sixty-odd.

A life of intense energy, breadth of intellect, generosity of sentiment and an unwavering trust in his science has brought Prof. Lowe wealth, fame, and position, socially and intellectually.—*Street Railway Review.*

IMPROVED STONE SAWING MACHINE.

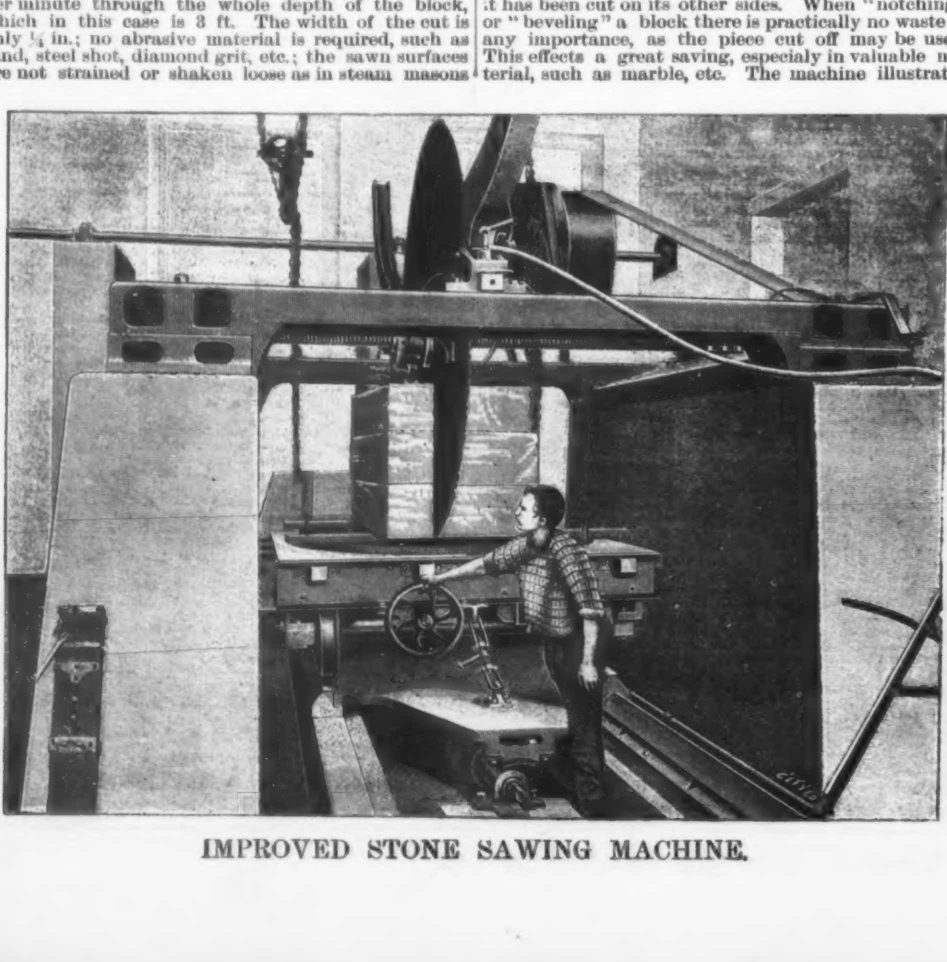
We illustrate a stone sawing machine erected for W. Thornton & Sons, Liverpool, on the site of the large church which they are now building at Heaviley.

We are indebted to *Engineering* for our engraving and the following description: The stone of which the building is constructed is very hard grit, and is being sawn into slabs and blocks of various dimensions, almost with the same facility as timber is sawn by an ordinary circular saw, or from 20 to 50 times quicker than by any other method. Blocks are sawn into slabs, on all four sides, perfectly straight and square, without touching them by hand, and no further dressing is required after they leave the machine. Although the stone referred to is of an exceedingly hard and gritty nature, it is being sawn at the very high speed of 6 in. per minute through the whole depth of the block, which in this case is 3 ft. The width of the cut is only ¼ in.; no abrasive material is required, such as sand, steel shot, diamond grit, etc.; the sawn surfaces are not strained or shaken loose as in steam masons or stone dressing machines, and the saws will "notch," "bevel," and cut at any angle. The driving power used is 14 actual horse power.

We are informed that similar machines are already in use in Germany, France, Belgium and Switzerland, sawing marble (at a rate of from 8 in. to 12 in. per minute through the full depth of the block), basalt, lava, etc.

The saw blade is constructed of steel ⅜ in. in thickness, with diamond teeth fixed into it; it is mounted on a steel screwed shaft, driven at a speed of 400 to 1,000 revolutions per minute in the manner illustrated; it can be moved horizontally in either direction, and fixed in any position, so that the block can be sawn into a large number of slabs without disturbing it. The block of stone to be sawn is loaded on to a truck running on rails. This truck is provided with a revolving table which may be turned in either direction at any angle to the saw, or completely round if necessary. The periphery or edge of the saw is prevented from vibrating unduly, and deviating from the vertical, by suitable guides. The box, or cover over the saw blade, collects the water which is carried up by the saw, whence it drops upon the block and contributes in maintaining an abundant supply of water in the cut or kerf.

The rate of feed varies from 1 in. to 20 in. per minute, in accordance with the hardness of the rock. Blocks may be cut at any angle by adjusting the revolving table with the hand wheel, also at angles to the horizontal plane, either by packing or raising the block to the desired pitch, or by turning it over after it has been cut on its other sides. When "notching" or "beveling" a block there is practically no waste of any importance, as the piece cut off may be used. This effects a great saving, especialy in valuable material, such as marble, etc. The machine illustrated below has been erected by Mr. James T. Pearson, Burnley, Lancanshire.



IMPROVED STONE SAWING MACHINE.

THE ZIMER BOAT.

THE patent Zimer boat consists of a main boat (propelled in any convenient manner, but specially suitable for propulsion by foot power), with movable outside floats. The latter are under the constant and immediate control of the occupants, being so arranged that when the boat shows a tendency to roll over on one side, the float on that side is instinctively and automatically dipped into the water by the occupants, with the effect of instantly righting the boat, in consequence of the exterior buoyancy or leverage counteracting both the "top-heaviness" of the boat and the side pressure of the water. The Zimer floats can be adjusted so as to be, when the whole boat is in her normal position, more or less in or entirely out of the water; in the latter case, the smallest possible resistance is offered to the progress of the craft. So powerful and instantaneous is the effect produced by manipulating the Zimer floats, that the question of stability calls for no consideration whatever in the construction of the main boat, enabling all attention to be concentrated on the fine lines of the latter, in order to produce ideal crafts for fast traveling.

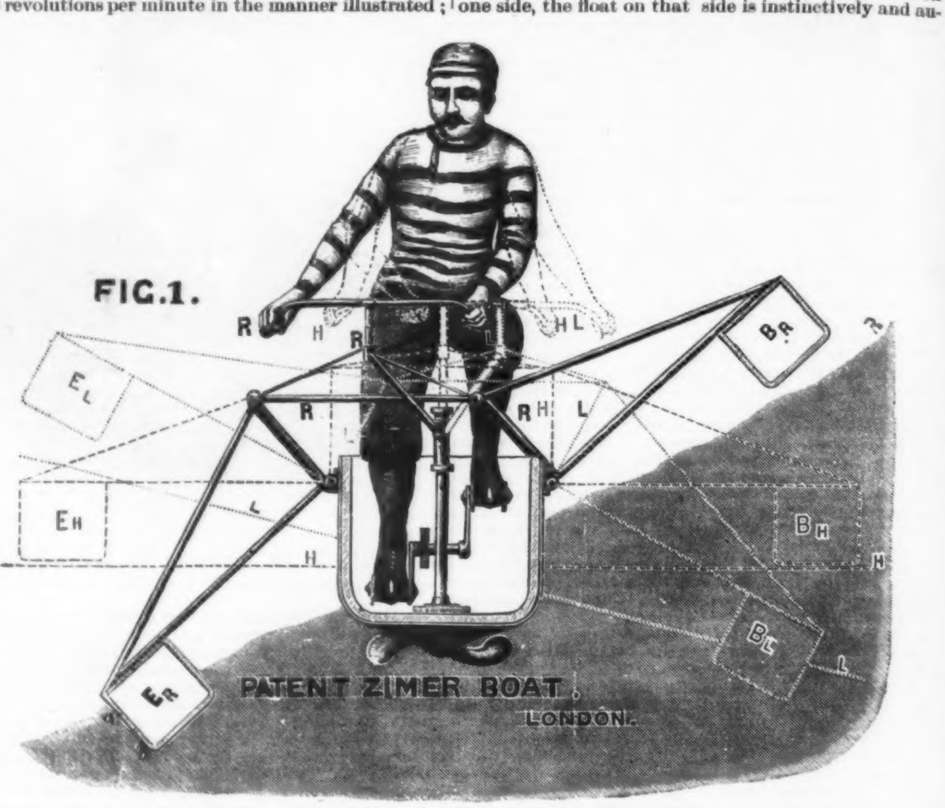


Fig. 1 shows the front view of a patent Zimer boat, with the hulls of the main boat and floats in cross section, carrying an operator working a screw propeller and automatically manipulating the Zimer floats. The picture or shaded part represents the boat riding lengthwise on a wave (R). The broken lines lettered H indicate the position of the operator's arms and floats when the boat moves on horizontal water, or on the top of a wave; and the dotted lines, L, show the position of the floats, etc., when the boat rides on the other side of the wave. The centers of the movable frames carrying the floats run parallel to each other. A stiff cross bar, with a knuckle joint at each end, establishes a connection between the two floats in such a manner that they move freely, but in opposite direction to each other—*i. e.*, if float, E, is moved in an upward direction, float, B, is pushed downward by the cross bar. A handle bar moving about a vertical center post, and thus furnishing an easy and suitable rest for the operator's hands, is in direct communication with the cross bar, or the two floats.

By slightly turning the handle bar, the floats assume a swinging motion in opposite directions to each other. On the occupant feeling any tendency to lose his balance, he will instinctively turn the handle bar in the direction of his fall, thereby dipping the float on that side into the water, and anticipating or arresting with the greatest ease the capsizing or rolling motion in its first stage, so that subsequently, if riding on the side of a wave, only a slight pressure with his hands will be needed to counteract the one-sided pressure of the water against the boat. In fact, even this side pressure would cease to exist by inclining the boat very slightly toward the side whence it comes, as it would be counteracted by the small amount of top-heaviness forced on that side.

By dipping the Zimer float, E, into the water (position ER), a powerful leverage is created diametrically opposed to the side pressure. The power required for dipping the said float, ER, is derived from the "top heavy" condition of the boat tending to throw the weight of the operator in the direction of float, E. The opposite float is lifted at the same time above the water (position BR), thus not only averting the capsizing of the boat by its buoyancy in the water, but, in addition, helping to keep the boat upright by the leverage of its weight when out of the water. This means that two dangerous forces, which combine themselves in the case of an ordinary boat in order to promptly upset her, are, in the case of the Zimer boat, played out against one another, with the invariable result of keeping the boat always in an upright position.

The Zimer boat consists of the usual pedal crank, or treadle motion, as used on road cycles, from which the power is transferred either by means of bevel wheels

to a shaft with a screw propeller (as in screw steamers), or by means of chains or rods to a stern paddle wheel. The latter is suitable when extremely light draught is necessary; but for general use, and especially in rough water, the screw propeller claims the first place. Side paddle wheels present numerous disadvantages.

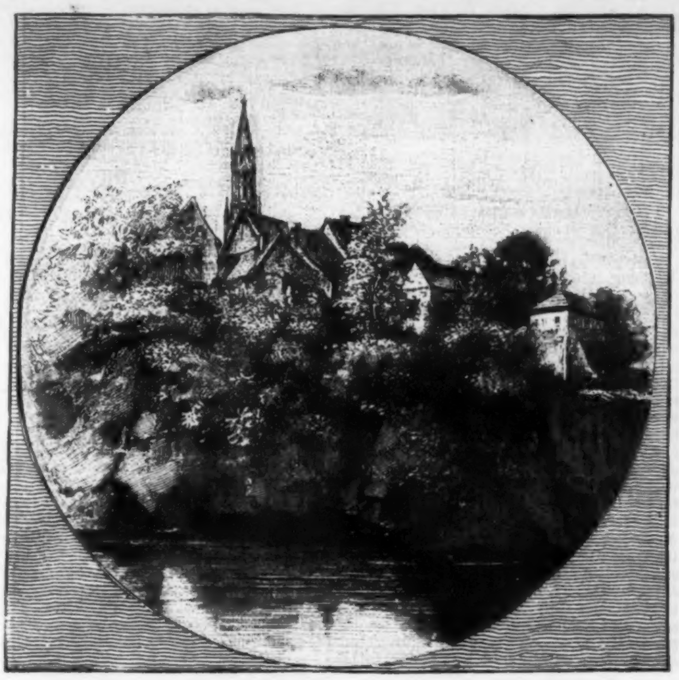
The most extensive use of the Zimer boat will undoubtedly be made at seaside places, where it will provide a delightful form of recreation for the many thousands who go there to amuse themselves. Although attracted by the fascinating influence of a large expanse of water, there have been hitherto no great inducements for the masses to venture upon the unstable element. Rowing, especially in a seaway, requires great skill and strength, and is indulged in as a pastime by a very small proportion of the holiday-making public.

The experiments have so far been made with a cheaply constructed rather heavy boat, 30 ft. long, greatest width 1 ft. 11¼ in. in the middle, propelled by a stern paddle wheel, which is working satisfactorily, excepting that there is more waste work than with a screw propeller, and that in rough water it is often out of or too far in the water; besides, the stern of this experimental boat is not suited for it, otherwise it has clearly shown that for very shallow draught the stern wheel is a decided success if properly constructed. During numerous trials in windy weather (October and November) with the above mentioned boat, and on choppy water well known for its dangerous character, the Zimer patent boat has stood the several tests with remarkable ease. The theory of the invention, therefore, having been proved by unqualified success in practice to be perfectly correct and never failing, the construction of the Zimer boats will admit of considerable modifications to adapt them for any particular purpose as regards comfort, fittings, and requirements. —*English Mechanic.*

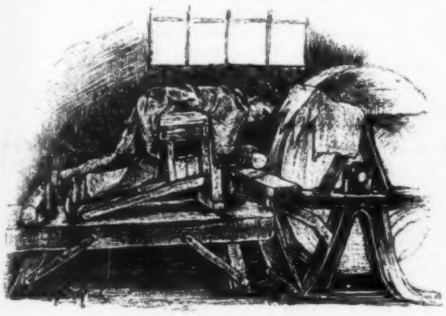
AGATE GRINDING IN GERMANY.

OBERSTEIN, on the River Nahe, has always been and continues to be one of the most active industrial places in Germany in the working and grinding of agates and semi-precious stones. Our picture represents a portion of a grinding mill in Oberstein. The grinding stones have generally been driven by undershot water wheels, but motion is conducted mostly by means of belts applied to the axles of the stones.

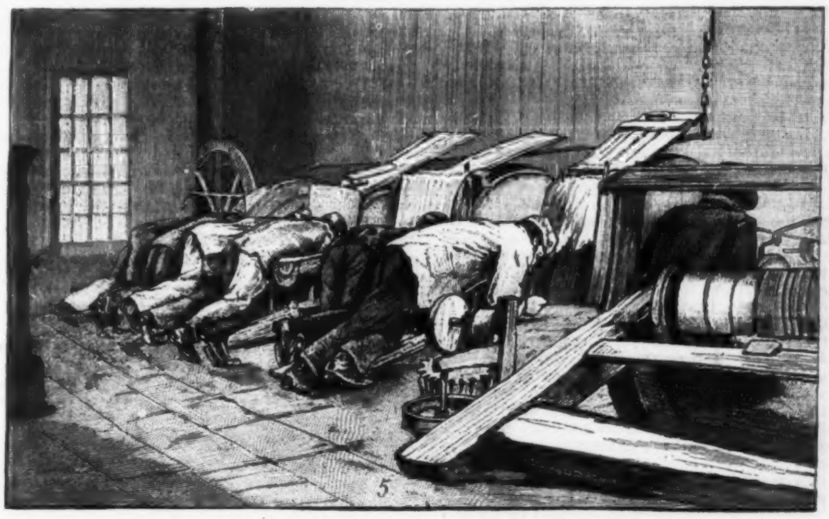
After the stone cutter breaks up the material into pieces, the agate grinder makes of them all kinds of useful and ornamental articles. The illustration gives to the reader an idea of the hardships of a grinder, who lies in a bent, horizontal position, upon hollowed wooden blocks; his face is close to the grinding stone,



THE CATHOLIC CHURCH, OBERSTEIN.



AGATE GRINDING.



AGATE GRINDING AT OBERSTEIN.

OBERSTEIN ON THE RIVER NAHE, GERMANY.

and his feet are supported against a block to keep the weight of the body always in the same elevated position. This very uncomfortable position of the workman, although not conducive to health, is considered necessary, in order to watch the grinding closely. This industry in Oberstein is not as flourishing as formerly, on account of the heavy duties and great competition in foreign countries.—*Ueber Land und Meer.*

[Continued from SUPPLEMENT, No. 899, page 14373.]

THE CHEMICAL TECHNOLOGY OF DRYING OILS, OIL BOILING, AND BLEACHING.*

By Professor W. N. HARTLEY, F.R.S., Royal College of Science, Dublin.

HOW TO TEST FOR LEAD IN BOILED OILS.

IN cases where it is desirable to have information of the presence or absence of lead in a boiled oil, the following test will be found most useful: A mixture is made of four ounces of glycerine with an ounce of ammonium sulphide, the liquid being kept in a stoppered bottle. Or glycerine is mixed with an equal volume of water, and saturated with sulphureted hydrogen. Half an ounce of the oil to be tested is placed in a white basin, with the addition of two or three drops of the glycerine solution. The two liquids are thoroughly incorporated by stirring with a strip of glass. A brown or black color, which gradually appears, indicates the presence of lead. A pure manganese oil simply becomes slightly yellow. It is true that, if iron is present, a black color might appear, but iron is also an undesirable impurity. Should it be required to ascertain that the coloration is or is not caused by iron, two or three drops of glacial acetic acid may be stirred into the oil, when, if the black color remains, it is certainly not caused by iron.

Several samples of the best boiled oil, including the principal makes of pale boiled oil, have been examined by this test, with the result that they were found in every case to contain more or less lead, thus:

Sample A (Brown Oil).—Turned quite black very rapidly. Contained much lead.

Sample B (Brown Oil).—Turned quite black very rapidly. Contained much lead.

Sample C (Brown Oil).—Turned very dark brown slowly. Contained much lead.

Sample D (Pale Boiled).—Turned dark brown. Contained lead.

Sample E (Pale Boiled).—Turned brown slowly. Contained a small proportion of lead.

The utility of this test may be understood when I mention the fact that it enabled me to detect the cause of the discoloration of the interior of a building which had been ordered to be painted with zinc white. The color was never quite so white as it should have been, because a brown oil was used. After a period of two or three years the discoloration became more marked, until at last the paint assumed a uniformly dirty appearance. When a sample of the oil used was examined by this test, it was found to contain lead.

Here it may not be out of place to remark that, under the old process of oil boiling at a high temperature, the brown color of the oil was, to some extent, an indication that the oil had been sufficiently heated—that is to say, properly boiled; but in the modern processes so largely used, in which oxidation is aided by a blast of air, this coloration is no indication whatever of the excellence of the oil; it may be, in fact, the very reverse.

This fact appears to be unknown or, at any rate, is not a matter of common knowledge among practical men in this country, who, being uninformed as to the methods of preparing the oils, consider that a brown color is desirable, if not essential.

Hence, in a specification of C. Binks, now thirty years old, it is stated that the objects of the invention are, first, to improve the drying properties of linseed oil; secondly, to obtain such drying oils in certain cases free, or comparatively free, from the deep or dark color usually pertaining to linseed oil; thirdly, to provide improved methods of obtaining dark colored drying oils similar in appearance and uses to those known as boiled oils. From which it appears that, in order to meet the prejudices of customers in favor of dark oils, he actually provides a means of darkening and spoiling an oil of superior manufacture.

When oil boilers were compelled to adopt some expedient to give a reddish-brown color to the oil, they added a small amount of litharge, the introduction of which actually spoils the oil and makes it unsuitable for many purposes to which it is otherwise applicable. (See article "Oil, Boiled Linseed," in Muspratt's "Dictionary of Chemistry," p. 472.) Of late years, pale boiled oils have been more largely manufactured for special purposes. It is obvious that for decorative house painting, in which delicate tints are a leading feature, they may be advantageously employed.

For, notwithstanding that some of the brown oils, when mixed with white lead, do not entirely retain the brownish tint, but to some extent lose it upon drying, yet they never preserve the whiteness of white lead. It follows, therefore, that a pale color in the oil, provided it is not the yellow color of raw oil, is greatly to be preferred. Moreover, when paints are mixed with zinc white, no trace of lead should be contained in the oil, otherwise one of the valuable properties of zinc white pigments is destroyed, namely, its power to retain its whiteness in the atmosphere of a town, because its color is not affected by sulphureted hydrogen.

Very generally zinc white and white lead paints are not mixed with drying oils, but with refined linseed or bleached oil. This, at any rate, is the practice on the Continent: that is to say, the pigments are mixed with an oil from which the impurities, and the natural yellow and red coloring matter, have been removed, so that the color of the paint is white. If ordinary oil be used, the paint is more or less yellow. In order to render such paint quick drying, a certain amount of driers, in a solid or liquid form, is added. These driers almost invariably contain lead, so that zinc white paint is contaminated by lead in another way, which may not be suspected, or which is overlooked.

One of the striking features of the process of oil boiling is the disengagement of very pungent and irritating vapors. These consist of formic and acetic acids, with a small proportion of acrolein, all of which result from the oxidation of glycerine. Acrolein is the aldehyde of acrylic acid, and it may be very readily oxidized by air; it is, therefore, by no means difficult to destroy it.

Its composition is C_3H_4O, and it is formed from glycerine, by the removal of the elements of water. Thus:

$$\begin{array}{ccccc} CH_2{\cdot}OH & & CH_2 & & \\ | & & \| & & \\ CH{\cdot}OH & = & CH & + & 2\,H_2O \\ | & & | & & \\ CH_2{\cdot}OH & & CHO. & & \\ \text{Glycerine.} & & \text{Acrolein.} & & \end{array}$$

Even the heating of any fat or fatty oil to a high temperature causes this decomposition to take place.

The acid substances formed by oxidation are,

Formic acid	$H{\cdot}COOH$.
Acetic acid	$CH_3{\cdot}COOH$.

ON DRIERS AND THEIR CHEMICAL ACTION ON OILS.

A drier or siccative material is any compound which is added to linseed oil, or to an oil paint, to hasten the drying of the latter.

Among these may be mentioned metallic lead, litharge, a mixture of litharge and manganese sulphate, of lead and manganese nitrate, red lead, lead acetate, lead linoleate, manganese borate, manganese dioxide, manganous hydroxide, manganese oxalate, manganese oleate, and manganese linoleate. These are mixed sometimes with anhydrous zinc sulphate or zinc acetate, or with dried alum. Some of these substances are only effective when heated with the oil.

THE ACTION OF SALTS OF ZINC AND ALUMINA IN OIL PAINTING.

Let us consider, first, the action of salts of zinc and alumina. Raw oil contains water and mucilage; the former can be absorbed by anhydrous zinc salts and by dried alum, and solutions of the salts and the salts themselves are capable of precipitating mucilage from the soil; hence these substances cause the impurities to become insoluble, so that they are carried down as "foots." Heat greatly facilitates this action, particularly by causing the oil to become more fluid, and by the action of the anhydrous salts, water is withdrawn from the oil. On the drying, or, more correctly speaking, on the oxidation of the oil, they exert no chemical action whatever. It has been shown, by G. A. Buchheister, that zinc linoleate and lead linoleate do not act as driers when simply added to the oil; he has also shown that, though the former is soluble in hot oil, it is insoluble in cold oil, and it therefore separates from the oil as it cools. The latter is very soluble in linseed oil, but only adds to its drying power when heated therewith.

THE ACTION OF METALLIC LEAD SALTS IN OIL BOILING.

Taken in conjunction with a high temperature, lead dissolves in oil at the expense of the glyceride which is decomposed into acrolein, while lead linoleate is formed. Thus, as we have seen by the action of heat and of dehydrating substances, glycerine itself is decomposed into acrolein and water:

$$\begin{array}{ccccc} CH_2{\cdot}OH & & CH_2 & & \\ | & & \| & & \\ CH_2{\cdot}OH & = & CH & + & H_2O \\ | & & | & & \\ CH_2{\cdot}OH & & CHO. & & \\ \text{Glycerine.} & & \text{Acrolein.} & & \text{Water.} \end{array}$$

In a manner somewhat similar linseed oil is decomposed by lead into acrolein, and lead linoleate in presence of air. It is here suggested that this action may be explained by the following equations:

$$2\left\{\begin{array}{l} CH_2{\cdot}OC_{18}H_{31}O \\ | \\ CH{\cdot}OC_{18}H_{31}O \\ | \\ CH_2{\cdot}OC_{18}H_{31}O \end{array}\right\} + 3\,Pb. + O.$$
$$\text{Trilinolein.}$$

$$2\left\{\begin{array}{l} CH_2 \\ \| \\ CH \\ | \\ CHO \end{array}\right. + 3\,Pb.\left\{\begin{array}{l} OC_{18}H_{31}O \\ OC_{18}H_{31}O \end{array}\right. + H_2O.$$
$$\text{Acrolein.} \qquad \text{Lead linoleate.}$$

When litharge is heated with linseed oil, the action is somewhat similar, the substances formed being acrolein, lead linoleate, and linoleic acid, thus:

$$\left\{\begin{array}{l} CH_2O{\cdot}C_{18}H_{31}O \\ | \\ CHO{\cdot}C_{18}H_{31}O \\ | \\ CH_2OC_{18}H_{31}O \end{array}\right. + PbO =$$
$$\text{Trilinolein.} \qquad \text{Litharge.}$$

$$\left\{\begin{array}{l} CH_2 \\ \| \\ CH \\ | \\ CHO \end{array}\right. + Pb\left\{\begin{array}{l} O{\cdot}C_{18}H_{31}O \\ O{\cdot}C_{18}H_{31}O \end{array}\right. + HO{\cdot}C_{18}H_{31}O$$
$$\text{Acrolein.} \qquad \text{Lead linoleate.} \qquad \text{Linoleic acid.}$$

If we consider the action of red lead on trilinolein, we have not only the formation of these lead linoleates, but an excess of oxygen available for the oxidation of glycerine to acrolein and acrylic acid, or to acetic and formic acids.

These equations serve to show the effect of lead and lead oxides in what may be termed the initiation of the chemical action upon the oil. Subsequent changes, no doubt, depend upon the conditions which obtain at the time, notably upon the temperature and upon access of air to the oil. It is probable that acid linoleates are formed, and that compounds formed from the polymerization of linoleic acid result eventually.

THE ACTION OF LEAD LINOLEATE AND LEAD ACETATE IN OIL BOILING.

It has already been mentioned that Buchheister could not find any chemical action caused by the presence of lead linoleate in oil, unless it is heated to a high temperature, and then it certainly appears to act as a drier. The same is correct when stated of lead acetate; but if this latter salt be heated in oil, probably some lead linoleate is formed, and acetic acid liberated.

THE ACTION OF MANGANESE COMPOUNDS ON OIL BOILING.

Whatever doubt there may be as to the action of lead salts, there can be none whatever as to that of manganese compounds. In the first place, manganous oxide is a powerful base, which readily dissolves in oil; manganic oxide is also readily soluble, yielding fatty acid salts of manganese, and causing oxidation of glycerine. Manganese borate and manganese oxalate are both soluble in oil, the former much more readily than the latter, but they are both salts of little stability at high temperatures in contact with oils. They both dissolve, by the aid of heat, forming fatty acid salts of manganese. Borate liberates boric acid under these circumstances, but oxalate yields a mixture of carbon monoxide and carbon dioxide.

Of manganese oleate and linoleate nothing more may be said than that both are extremely soluble in oil, and both easily oxidized from colorless to brown compounds when submitted to the action of air.

WHAT IS IT THAT CONSTITUTES A DRYING OIL?

Much important work has recently been published, which throws a light upon the chemical structure of the acids which enter into the composition of drying oils.

Alexander Saytzeff obtained dihydroxystearic acid from oleic acid by oxidizing it with potassium permanganate in an alkaline solution.

Dieff and Reformatsky examined ricinoleic and linoleic acids in the same way, and obtained from the former trihydroxystearic acid and from the latter tetrahydroxystearic acid. (*Berichte Deutschen Chem. Gesell.*, vol. 20, p. 1211.)

K. Hazura, in the same manner, investigated chanvroleic acid (from hemp oil) and linoleic acid, and proved the two to be of similar constitution if not identical. (*Monatschrift fur Chemie*, vol. 7, p. 637; loc. cit., vol. 8, pp. 147–156.)

Hazura and Friedreich examined poppy and nut oils, with the result that the acid of each has been identified with linoleic acid. (*Monatschrift fur Chemie*, vol. 8, p. 156–165; *Bulletin de la Societe Chimique*, vol. 48, pp. 367 and 516.)

Subsequently Hazura proved that linoleic acid consists of two substances, one of which he termed linolic, and the other linolenic acid. (*Monatschrift fur Chemie*, vol. 8, p. 260–271; *Bulletin de la Societe Chimique*, vol. 49, p. 140.)

Chanvroleic acid was identified with linolic acid; hence this acid is contained in poppy, hemp, and nut oils. The following are the principal drying oils, and the substances which confer upon them the property of drying or hardening under oxidation:

Castor oil	contains	ricinoleic acid.
Nut oil	"	linolic "
Hemp oil	"	linolic "
Poppy oil	"	linolic "
Sunflower oil	"	linolic "
Linseed oil	"	linolic and linolenic acids.

The products of the oxidation of linolic acid are sativic and azelaic acids or sativic acid only. Under the same conditions linolenic acid yields an acid called linusic. Now sativic acid is a tetrahydroxystearic acid, and linusic acid is hexahydroxystearic acid, accordingly in the following tabulated statement the relationship of these acids is made apparent. It will also be seen that the non-saturated fatty acids, when oxidized with a solution of alkaline potassium permanganate, combine with as many hydroxyls as their carbon atoms are free to unite with, and are thereby converted into saturated hydroxy acids containing the same number of carbon atoms as the original molecules from which they were derived:

Unsaturated Acids.			Saturated Hydroxystearic Acids.	
Linolenic acid	$C_{18}H_{30}O_2$	yields	hexhydroxystearic acid	$C_{18}H_{30}O_2\,(OH)_6$
Linolic "	$C_{18}H_{32}O_2$	"	tetrahydroxystearic "	$C_{18}H_{32}O_2\,(OH)_4$
Ricinoleic "	$C_{18}H_{33}\,(OH)O_2$	"	trihydroxystearic "	$C_{18}H_{33}O\,(OH)_3$
Oleic "	$C_{18}H_{34}O_2$	"	dihydroxystearic "	$C_{18}H_{34}O\,(OH)_2$
Elaidic "	$C_{18}H_{34}O_2$	"	dihydroxystearic "	$C_{18}H_{34}O\,(OH)_2$

C. Michael and A. Saytzeff obtained a compound which they regard as the anhydride of hydroxystearic acid, with the composition $C_{36}H_{68}G_4$, or

$$\begin{array}{l} O{-}C_{17}H_{34}{-}CO \\ |\qquad\qquad\quad | \\ CO{-}C_{17}H_{34}{-}O \end{array}$$

(*J. fur Prak. Chemie* (2), vol. 35, p. 369; *Bull. Soc. Chimique*, vol. 48, p. 516).

When an oil is boiled, undoubtedly hydroxy acids, or their anhydrides, are formed; and most likely the substance termed by Mulder *linoxyn* is an anhydride of similar type, as regards constitution, to that obtained by Michael and Saytzeff; but, instead of being produced from a dihydroxy acid, probably of more complex structure, being the result of a greater degree of oxidation.

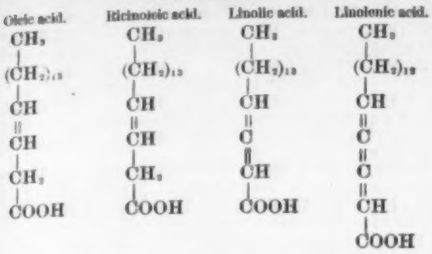
According, however, to the latest work of Reformatsky (*Jour. Chem. Soc.*, vol. 58, p. 362), it is an open question whether linoleic acid is really a heterogeneous substance, as Hazura states it to be, since he could only obtain tetrahydroxystearic acid therefrom.

* Lecture before the Society of Arts, London, February, 1893.—From the *Journal.*

THE CONSTITUTION OF UNSATURATED ACIDS.

Probable Formulæ.

Oleic acid. Ricinoleic acid. Linolic acid. Linolenic acid.



ADULTERANTS OF LINSEED OIL AND OF BOILED OIL.

The chief adulterants are cottonseed oil, resin oil, and linoleic acid. It has been shown by Livache (*Comptes Rendus*, vol. 96, p. 260) that cottonseed, which is to some extent a drying oil, can act as such when mixed with linseed, but that when added to olive oil, it behaves as a non-drying oil. In fact, its behavior is anomalous, and of such a character that it greatly facilitates its extensive use as an adulterating material for the more expensive oils. In my own experience, a linseed oil of high repute has been found to contain a considerable quantity of what appears to be cottonseed oil, although sold as linseed, and this has been converted into drying oil; but had pure linseed oil been operated upon by the same process, the resulting product would have possessed much more satisfactory properties. I have likewise had samples of linseed oil adulterated with resin oil, a deleterious adulterant, but one which may be more readily detected than cottonseed oil. Resin is added to boiled oil to hasten its drying; this also is an injurious substance. Of late years glycerine has become an article of greater value than formerly, and this may account for the manufacture of linoleic acid and its use as an adulterant of oleic acid as shown by M. Ferdinand Jean; and as an adulterant of linseed oil, as the analyses of Prof. Wefer Bettink indicate. The latter case is very instructive. A sample of linseed oil was found to conform to the standard of purity at present laid down, but it turned out to be perfectly useless for painting purposes, as when mixed with white lead the paint became brittle in a few hours. There was found to be free linoleic acid to the amount of 34 per cent. present in the oil, which must have been willfully added. (*The Analyst*, vol. 15, p. 79.)

Lastly, it may be mentioned that certain samples of "pale boiled oil" have been found to contain what is practically a raw oil mixed with driers. Although such oils will dry, their efficiency is nothing like so great as that of an oil "boiled" with a blast of air at a suitable temperature, and, moreover, such oils are deficient in body.

ON THE BLEACHING OF OILS.

In treating of the bleaching of vegetable oils, it is necessary to consider the nature of the coloring matters contained naturally in such oils. These consist of a mixture in varying proportions of the coloring matters known to exist in the leaves of plants, but which, in the case of oils, are derived from the fruit, such as olives, or seeds, such as linseed, from which the oils are expressed. There can be no doubt that these substances are closely allied in chemical constitution; they all possess an intensely powerful coloring property, by which I mean that though the color of some of them may not be dark, yet a very minute weight is capable of imparting a tint to a very large quantity of material.

The names of these substances are:

Xanthophyll—yellow.
Yellow chlorophyll—yellow.
Blue chlorophyll—blue.
Erythrophyll—red.

In some oils only the xanthophyll and yellow chlorophyll are present; in others, such as olive oil, the yellow and blue chlorophylls occur, and give the liquid a green tint, while in linseed erythrophyll is always present with more or less of the yellow and blue chlorophylls, and some xanthophyll. According to the different proportions of these coloring matters, the oil varies in color. For instance, linseed oil when brown contains a mixture of erythrophyll with yellow and blue chlorophylls; when greenish brown, the yellow and blue chlorophyll are present in somewhat larger proportion, but mixed with erythrophyll; while generally speaking, a bright yellow or pale yellow oil contains xanthophylls only. These substances appear to be combined with the oils, or to be substances of a fatty nature. They are neither dissolved nor acted upon by water, nor by acids diluted with water, when naturally contained in the oils. They are freely soluble in alcohol, and an alcoholic solution is not only susceptible of being destroyed by the joint action of air and water, but by very dilute aqueous solutions of mineral acids, and by acetic acid. In aqueous and alcoholic solutions, light speedily modifies the blue, and eventually destroys all these colors. A solution in turpentine of the isolated coloring matters is also easily destroyed. But, on the other hand, a solution of the colors in melted paraffine wax is comparatively stable.

Zinc hydroxide, copper hydroxide, baryta potash, and soda combine to form metallic salts with blue chlorophyll, less readily though readily enough with yellow chlorophyll, but far less readily with xanthophyll and erythrophyll. The following facts will serve to show that this is the case. When a solution of the coloring matters contained in green leaves is made by extracting dry but freshly gathered leaves with absolute alcohol, an addition of a saturated solution of baryta water added to the intensely green extract, precipitated at first the compound of blue chlorophyll with baryta, then a further addition precipitates the yellow chlorophyll, also as a baryta salt; but xanthophyll and erythrophyll either remain in solution, or require a much larger addition of the base in order to be precipitated. A crystalline compound of blue chlorophyll with soda has been obtained by Guignet, which is comparatively stable. This substance is, no doubt, formed in green vegetables when they are boiled in water to which some carbonate of soda has been added, to maintain their fresh appearance. The addition of a small trace of copper sulphate to peas and to pickles forms a very permanent copper compound with the coloring matter, which gives an attractive appearance to these articles. Such being an outline of the chief chemical properties of the natural coloring matters contained in oils, the facts mentioned will serve to render the processes for removing the color from oils more intelligible than they otherwise would be.

Vegetable oils are decolorized, either partially or completely, by the application of one of the following agents, or chemical processes:

1. By the action of light, or by the joint action of light and air.
2. By acids.
3. By saponification.
4. By the action of chlorine.

1. By exposing raw linseed oil to the action of sunlight, it slowly becomes pale in color, and finally colorless. It is in the highest degree probable that as oxygen is absorbed by the oil and acids, substances are thereby produced, that these acids effect the destruction of the coloring matters. In such wise castor oil is bleached.

2. By treating linseed oil with moderately strong sulphuric acid, as in the process of refining the oil first proposed by Thénard. As the oil and sulphuric acid are of very different specific gravities, it is essential that they be very rapidly and thoroughly mixed by violent agitation. The impurities, such as mucilage and albuminous matters, are thus deprived of water, and more or less charred, and along with them, the coloring matters are destroyed by the acid. It is essential for the success of the process that the oil and the acid be not long in contact without undergoing dilution, otherwise the oil itself may become charged. It is, however, possible to obtain oil by this process in a fairly colorless condition, after it has been thoroughly washed with water, and allowed to settle.

3. Both rape oil and cotton oil may be rendered of a pale yellow, and even almost colorless, by a process of partial saponification with caustic alkali of a suitable strength. The coloring matters are saponified, and the resulting soap is of a dark yellow or brown color, from the coloring matter having combined with the alkali.

4. By the action of chlorine produced in contact with the oil when, for instance, an aqueous solution of bleaching powder is acidified with a cheap mineral acid, such as dilute sulphuric. In this case rapid mixing and violent agitation are essential to the success of the process, otherwise chlorinized products are retained in the oil, which not only confer upon it a distinct flavor and odor, but also cause the oil to solidify with a very moderate lowering of the normal temperature. It is very questionable whether drying oils can, with advantage, be submitted to such treatment.

5. A variety of methods may be merely mentioned, such as treatment with sulphurous acid, with ferrous sulphate (green vitriol), and potassium dichromate and sulphuric acid. L. E. Andé's "Oel und Buchdrük Farben."

6. Lastly, there is the method of Binks, to which I shall have to refer further on.

ON A NEW PROCESS FOR THE PREPARATION OF DRYING OILS OF A PALE COLOR.

Having thus far dealt in outline with the chemistry of drying oils, I propose to give a short account of certain improvements in the process of oil boiling, which are founded upon a rational basis, and designed with the object of producing a drying oil absolutely free from lead, and, as compared with ordinary oils, absolutely free from color.

The operations have been carried out, on a manufacturing scale, by Mr. W. E. B. Blenkinsop and myself, and there is no doubt, therefore, of the practicability of the process.

The process, as carried out by us, consists in, first, refining the oil, by the removal therefrom of water and mucilage; second, boiling and bleaching the oil at one operation.

It is a fact that water and mucilage can be removed from linseed oil by the action of certain dehydrating substances and solutions of metallic salts, as, for instance, by alum, by strong sulphuric acid—as in Thénard's process—and also as Wagner has proposed, by a solution of zinc chloride.

There are certain objections to each of these methods, which are of a practical nature; thus, in treating the oil with strong sulphuric acid, there is too frequently a charring of something, either the oil itself or of some impurity therein, and this charring, though it may be very slight, has the effect of giving a slight brownish tinge to the oil, which cannot be completely removed by the bleaching process to which the natural coloring matters in the oil are amenable. It is quite true that this brown color separates sometimes, but it is only after storage for a long period, when a finely divided flocculent matter separates by subsidence. Treatment with zinc chloride is satisfactory but expensive. Perfectly pure manganese sulphate, which is a neutral salt, has been used by us in very strong solution, and we should employ such a material where there is an objection to using an acid. For ordinary purposes we have found that perfectly satisfactory results are obtained by the use of a dilute sulphuric acid, containing about 30 per cent. of H_2SO_4, since, though it possesses the power of withdrawing water from the oil, it may remain in contact therewith without causing any charring, and at the same time it causes the precipitation in a complete and rapid manner of all the mucilage. A purified linseed oil is thus produced which is bright, clear, and slightly yellowish in color, though somewhat paler than the ordinary oil. It is important that the strength of the oil should not exceed that degree of concentration which is sufficient for the purpose for which it is intended. The oil having been so treated, and the impurities separated by subsidence or otherwise, it is next submitted to the bleaching and oxidizing treatment. It is well known that C. Binks bleached oils and boiled linseed with oxides of manganese dissolved in the oil, but it is also apparent, from the specifications which he filed, that some difficulty was experienced in carefully regulating the quantity of the manganese compounds which were to be introduced into the oil. For instance, he precipitated manganous hydroxide in contact with oil, and added the mixture to the bulk of the material, and he also modified the treatment by dissolving manganous hydroxide in ammonia, and added the solution to the oil.

In our process we prepare manganese linoleate, and dissolve this in a hydrocarbon, and add a sufficient quantity of the solution to the oil, whereby it dissolves easily, and completely mixes therewith. By this treatment, the coloring matter of the oil forms a compound with the manganese which, while it remains in solution, is very speedily oxidized in contact with air, especially when a current of air or oxygen is blown through. The oxidation destroys the coloring matter, and the manganese compound is deoxidized, subsequently it undergoes oxidation again, and the products of such oxidation taking place in the oil are acrolein, formic and acetic acids. After or concurrently with the oxidation of the coloring matters, the oil is oxidized, and, at a suitable temperature below 132° C., the oil is bleached, increased in density, and converted into a pale drying oil. By limiting the amount of the manganese linoleate to that which is capable of just oxidizing the coloring matters, oils may be bleached with very little further oxidation.

Excellent drying oils have been produced by this process, of a very pale color, samples of which are exhibited. The oil has been used for decorative house painting, for both indoor and outdoor work, on wood and on metal. It has also been used as a coating for iron work, without the addition of a pigment. The plant used in its production is the same as that employed in oil boiling by the usual processes, when a blast of air is used.

In order to show the advantage of using an oil of this description over that of ordinary boiled oil, it is necessary to point out the defects in usual makes of drying oils used by painters generally.

1. Zinc white, mixed with ordinary boiled oil, darkens.
2. Patent non-poisonous white lead, painted with ordinary boiled oil, darkens.
3. Paints made with lead sulphate and ordinary boiled oil, darken.
4. All delicate colors are darkened if mixed with ordinary boiled oil.

The advantages of a pale boiled oil, containing no lead, are the following:

1. Zinc white retains its pure white color.
2. Delicate tints, and colors containing sulphides, are not darkened in course of time.

It may be suggested that for indoor decoration, for the painting of ships, railway carriages, railway semaphores, signs, and stations, such oil is free from liability to alter the colors with which it is mixed, owing to its freedom from lead, which is darkened by traces of sulphureted hydrogen in the air, to which such paints are exposed.

Gasometers in gas works may be painted an unalterable white with such oil and zinc white. But in this case also the zinc white must be free from lead carbonate or oxide.

The following specimens were exhibited to illustrate the description of Messrs. Hartley and Blenkinsop's process for bleaching oils and preparing pale boiled oils:

(1.) Six samples of ordinary brown boiled oil from different makers.
(2.) Five samples of pale boiled oil from different sources.
(3.) A sample of raw linseed oil, showing natural coloring matters.
(4.) The same purified from mucilage. (H. and B.'s process.)
(5.) The same, bleached.
(6.) The same, converted into boiled oil.
(7.) Samples of bleached linseed, poppy, and cottonseed oil.

Various lead and manganese compounds used as driers were shown.

Experiments were made, which showed the effect of the lead in ordinary boiled oil, and in pale boiled oil on delicate colors, and on zinc white, when exposed to impure air.

Panels painted with zinc white and pale boiled oil, prepared by the new process, were shown to be not only of purer color, but quite unaffected by sulphureted hydrogen.

GREASE EXTRACTION FROM WOOL.

A METHOD of and machine for extracting fat or grease from wool has been patented by Mr. J. Rhodes, Sydney, Australia. The apparatus consists of a number of similar machines joined together, each of which contains: First, a hopper for a volatile solvent; second, a traveling apron underneath the hopper and upon which the wool is placed; and, third, a conical shaped vessel into which the solvent drains. These vessels are supplied with an arrangement which causes the dirt from the wool to sink to the bottom. It consists of an inverted hood placed in the vat, upon which the solvent drops and runs over and down the sides, and the clarified solvent is drawn off from inside the hood, so that any refuse must remain at the bottom of the vat. The action of the machine is as follows: The raw wool is thrown on the top of the traveling apron and carried under the hopper, where it receives a shower of solvent. This acts upon and dissolves the wool fat, which, with the dirt on the wool, is carried down into the vessel below. The purified wool passes on through several of these machines and, during its passage, more and more of the wool fat is extracted, until, when it leaves the last of the machines, it is quite clean, after which it is dried. The solvent used in the last machine is sent by suitable lifting apparatus to the next member of the series, where it is used over again, and so on throughout the series, so that, as it passes through the machine, it becomes more and more charged with wool fat. Finally, it is sent into a still where it is distilled off to be used again. The wool fat remains behind and can be employed for a variety of purposes. The main objection to the plant is that it exposes a large surface of solvent to the action of the air, and, in addition to the loss by the evaporation, there must necessarily be some inconvenience to the workmen and a possibility of fire taking place. In all processes and machines for extracting fat from wool, every care should be taken to avoid over-exposure of the solvent to the air.

PULVERIZATION.

THE necessity of reducing substances to powder certainly dates back to the remotest antiquity, but it is absolutely impossible to determine the epoch at which this operation took rise. It is evident that the needs of man, nutriment, for example, must have given birth in his brain to rudimentary processes. Now, it is not less evident that the art of making bread dates from a

FIG. 1.—PULVERIZATION OF POISONOUS SUBSTANCES.

prehistoric epoch. But how many years passed between the discovery of wheat and the manufacture of bread, that is to say, before it was known that the grain yielded flour!

It is admissible that the first substances ground were ground between two stones; but, since the material was scattered on every side, there was but a step to the idea of making a cavity in the stone. This was the embryo state of our present mortar. Then the two cones, one within the other, between which the grain was crushed through the rotary motion given the external cone, while the internal one remained stationary, constituted the mill of the first Romans. This was the beginning of refining.

The quality of the powder obtained by so rude a process of grinding may be easily imagined. A consequence of this state of things was the advent of the sieve, the object of which was the separation of the flour from the hull of the grain. Here again we find ourselves in the presence of a crudeness easy to understand, especially to judge of it by the bread found in the mummies of Egypt, containing coarsely ground wheat. Sifting was likewise gradually perfected--at least this is what must be inferred from Pliny's "Natural History," which tells us that the Egyptians were acquainted with the sieve and that they made it of filaments of papyrus and of very slender rushes. The ancient inhabitants of Spain made sieves of thread, and the Gauls were the first to employ horse hair for the purpose.

We do not wish to undertake to write a complete history of grinding, but shall at once touch upon an operation which, it may be said, is the complement of it, and is, at present, the object of an important and little known industry, that of pulverization. Up to the first quarter of this century, substances were pulverized by means of the traditional mortar and pestle, either in the shop of the druggist or apothecary, or in the laboratory of the chemist, or else by the manufacturers themselves, whose raw materials or products necessitated a pulverulent form. Progress becoming more marked, and needs becoming more and more urgent, it came about that the specialist or small manufacturer could not perform the manual labor of braying, and motive power became necessary. Hence the birth of a special industry—that of pulverization.

The object of pulverization is to reduce substances into particles of greater or less tenuity. Many industries are tributaries of it. For example: The drug trade and pharmacy employ it for all the medicinal plants, manufacturing chemistry makes use of it for almost all of its products, glass manufacture has recourse to it for manganese, fluorspar, etc.; tanners and tawers use it largely for tanning and coloring materials (such as dividivi, tanbark, campeachy, quebracho, etc.); soap manufacturers for soaps and lichens, perfumery for rice powder, sachets, etc.; the grocery trade for spices, etc.

Pulverization constitutes, in its entirety, in its methods, and in the diversity of the substances to be treated, an industry that requires on the part of whoever exploits it correct ideas upon the physical and chemical properties and the qualities of the different substances to be reduced to powder, for all bodies cannot be pulverized by means of the same processes. Finally, it is necessary to take account of the pathological and often poisonous action of many substances that have an effect either upon the interior of the organization, such as the salts of mercury and arsenic, or upon the exterior, such as ipecac, which, without certain precautions, affects the sight to such a degree as to render the workmen blind, or as cantharides, which acts as a vesicant. In the first case, the workmen whose duty it is to do manually or superintend the pulverizing are obliged to cover their mouth and nose with aseptic wadding, which they cover with a cotton or silk handkerchief (Fig. 1). In the second case, in order to prevent the action of substances that are capable of affecting the sight, they wear spectacles that are entirely closed at the sides of the eyes. Finally, as regards substances capable of irritating the skin, the workmen have to put on very light clothing, which they take off as soon as their work is finished, in order to put on other garments, so that the deleterious dust shall not have time to attack the epidermis. Owing to such prophylactic means, the gravest accidents are avoided.

The methods of pulverization are numerous. The principal ones are contusion, trituration and grinding; the others are friction, pulverization followed by trochiscation, dilution, efflorescence, the method by intermediates, and, finally, chemical reactions. These latter are themselves divided into three very distinct methods, which are precipitation, hydration and reduction. Before speaking of contusion and trituration, which form the subject of our engravings, we shall touch lightly, without dwelling upon, some of these methods of pulverization, which are too well known to be described, contenting ourselves with referring more especially to the method by intermediates, which will show how capricious matter is and will confirm what we have above said on the subject of our knowledge of the properties of certain bodies.

What is called the method by intermediates is a pulverization that can be effected only by the aid of an intermediate agent. Thus, for example, as camphor is too elastic to be pulverized by itself, it is necessary, in order to reduce it to a powder, to saturate it with ether or alcohol—very volatile liquids that it is easy to eliminate after the operation. Vanilla cannot be pulverized without the intermedium of sugar, and rice is softened in water before being ground. Melted lead and tin are obtained in a pulverulent state by agitating them vigorously in a spherical box coated with chalk or talc.

Centrifugal force is also an intermedium for the reduction of zinc to a fine powder. To this effect the molten metal is poured upon a Rostaring disk, which is nothing else than a horizontal plate of cast iron or fire clay mounted upon a vertical axle which turns at the rate of from 2,000 to 2,400 revolutions per minute, and by this means the zinc is projected against the sides of the box in which the disk is inclosed. We know also that gold and silver are easily pulverized in the presence of honey, sulphate of potassa or chloride of sodium, which are afterward removed with boiling water. Let us say further that in order to facilitate the extreme division of phosphorus, water charged with salts is used.

Finally, the powders known as bronzes are obtained by the very fine rolling of bronze, brass or copper clippings, which are then heated to different temperatures in order to give them various shades of color. In this state they are reduced to powder under millstones by mixing them with honey or molasses. The result of this operation is a paste that is washed with warm water in order to remove the intermedium employed. The water is then filtered off and the product is dried. These powders, according to their color, take the names of green bronze, Florentine bronze, white bronze, red golden bronze, pale golden bronze, etc. We think it unnecessary to point out their uses. They are often fixed to a shell with gum arabic, just like the genuine gold powder.

We have no space to speak of the method by chemical reactions, and shall at once enter upon the subject of contusion and trituration, which are the two most widely used methods. Contusion is pulverization by simple impact. In trituration we give the pestle a circular motion. This latter method is employed for substances that soften under the influence of numerous blows (such as gum arabic, resins, etc.) The state manufactories utilize this method in employing, instead of the mortar and pestle, casks revolving upon an axis, and in the interior of which iron balls roll. For poisonous substances, cast iron cylinders are substituted for the casks.

The view of a pulverizing establishment represented in Fig. 2 shows us two batteries of mortars and pestles. The first, figured to the right, operates by contusion, and the second, to the left, by trituration.

In these two processes the piece that raises the pestles is a cam whose axis is fixed upon the main shaft, which is actuated by a steam engine. In order to prevent lateral actions in the contusion battery, the cams revolve in a rectilinear opening in the rod of the pestle and which is seen to the right of our engraving. The

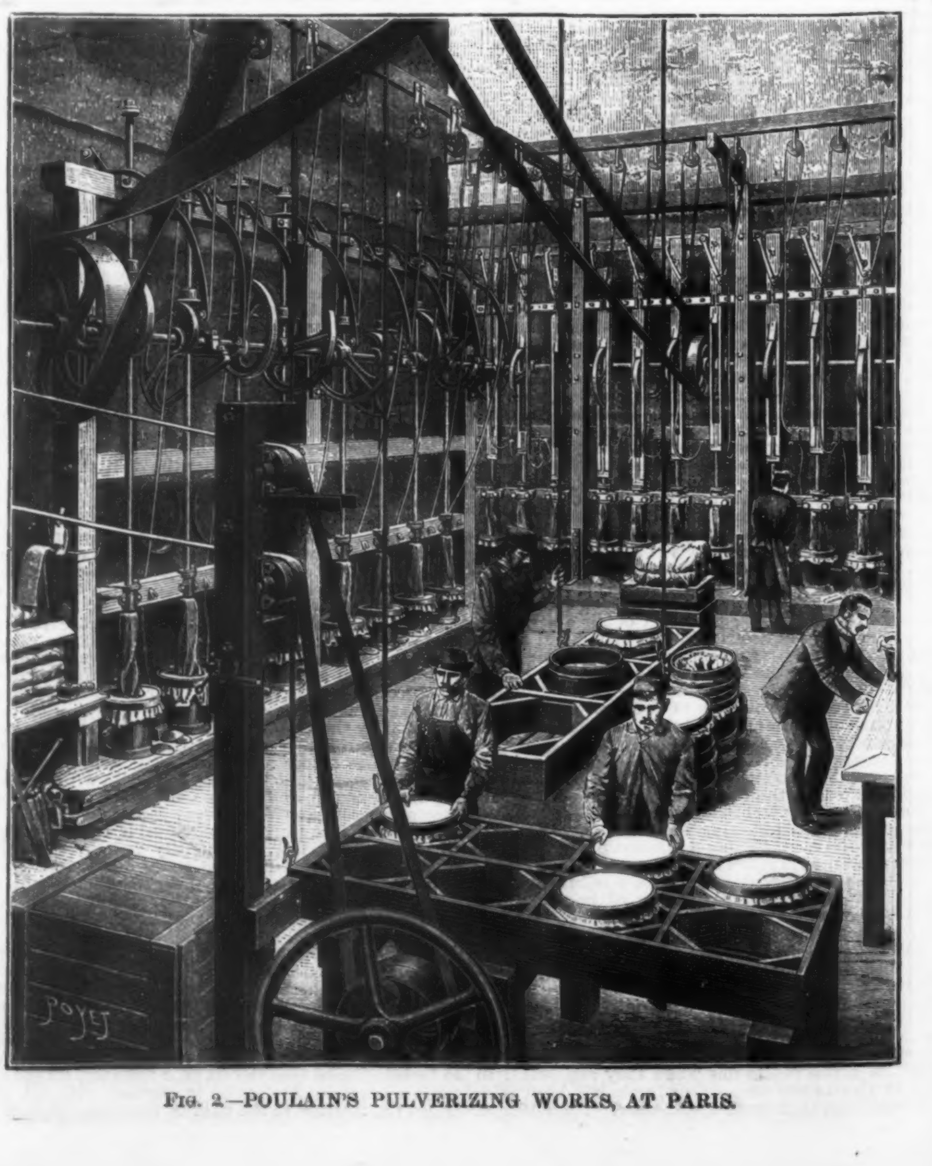


FIG. 2.—POULAIN'S PULVERIZING WORKS, AT PARIS.

cam, which is a spiral having the driving shaft as a starting point, is cut off short at 180°. On reaching this point the wiper escapes and leaves the pestle to the action of gravity.

In the trituration battery figured to the left of our engraving the pestles must, in falling, turn upon themselves. To this effect, the cam rubs against a wiper in the form of a horizontal circular plate that communicates, by reason of the friction, a gyrating motion to the pestle. In our figure we have indicated the different positions occupied by the cam during its revolution. These various phases will indicate the decomposition of such motion.

In order to prevent projections resulting from the impact, as well as diffusion of the dust, each mortar is covered with a leather jacket.

The operation of pulverization is terminated by bolting or sifting, the object of which is to give homogeneous powders of equal fineness. In the foreground of the figure may be seen tables carrying hermetically closed sieves, to which is given a to-and-fro mechanical motion. These tables are divided into compartments of octagonal form, in which the sieves are placed, which latter, always meeting with an inclined surface, turn upon themselves.

Before terminating we shall give a few explanations of the part forming the background of Fig. 1. The wheel observed here is a circular planer designed to convert medicinal woods into shavings. Here and there upon the rim are placed steel blades inclined at a certain angle. A workman is about converting some quassia into shavings. To this effect the wood is cut into small cubes, which the workman causes to advance against the planer by means of a screw actuated by a winch.

From what we have just said, our readers may form some idea of the importance of the pulverization industry, which has assumed extensive proportions, as may be seen when we state that in the establishment of Mr. Poulain, who has obligingly put himself at our service, forty men and a motive power of sixty horses work from one end of the year to the other in reducing the most diverse substances to powder.—*La Nature.*

AUTOMATIC MERCURIAL AIR PUMPS.

By AUGUST RAPS.

OF late years, and more especially during the last decade, men of science have devoted much thought and ceaseless energy to the invention of an apparatus which should admit of the automatic working of mercurial air pumps. Of the numerous inventions brought forward, the ingenious apparatus of Schuller and Stearn are especially deserving of mention.

But notwithstanding the present extensive employment of the mercurial air pump in science as well as in technics, these appliances are neither much known nor have they been used to any great extent, although they are of great importance, and would probably be very advantageous. This may be explained by the fact that they are wanting in the necessary simplicity and trustworthiness, without which the advantages of automatically working mercurial air pumps are somewhat doubtful.

We shall describe now an apparatus for the perfectly trustworthy and automatic working of mercurial air pumps, as well as the shape of the glass pump used in connection with it, which, while possessing the greatest possible simplicity, admits of the highest rarefactions hitherto known.

The figure shows the automatic apparatus in connection with an improved Toepler mercurial air pump. The glass ball, H, is connected on the one hand by flexible tubes with the pump, Q, on the other hand by the tube, L, with the accumulator, M. The water pipe, K, runs into the bottom of the accumulator, and by means of a specially constructed three-way cock, K, can either be connected with the hydrostatic pressure pipe, K_1, or the discharge pipe, K_2.

If water under pressure is admitted through the tubes, k_1, K and k into M, the air contained in M is compressed. This air again exerts a pressure through the tube, L, on the mercury contained in H, and drives it into the pump, Q. As soon as the mercury has risen sufficiently high and the cock, K, is reversed, the compressed air forces the water out again through k, K, and k_2, and the mercury falls down on account of its own weight out of the pump, Q, back into the ball, H.

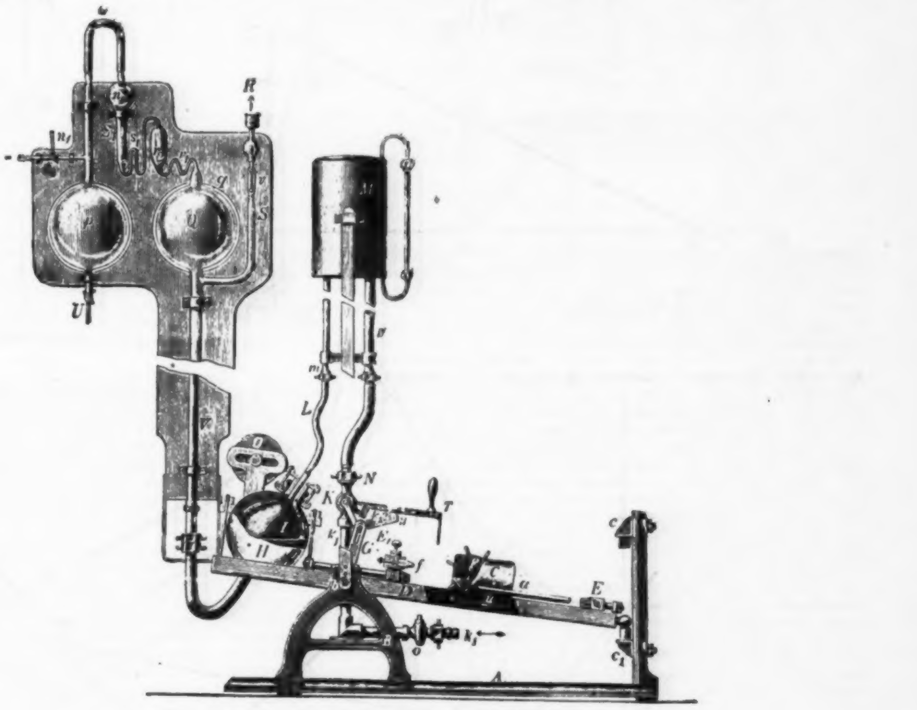
The reversing of the three-way cock, and therewith the automatic action of the pump, is effected in the following manner: The ball, H, rests on a frame, D, revolving about the axis, b, and the motion of which is limited by the ledges, c and c^1. A lever, G, is attached to the frame not far from the axis, and by means of a peg, when the balance, D, reverses its position, also turns the cock. When the ball, H, is entirely filled with mercury the balance, D, rests on the upper ledge, c. If the pump is set in motion the left side of the balance, D, becomes lighter in proportion to the amount of mercury forced out of the ball, H, into the pump, until at last the weight, C, on the hight-hand side becomes heavier, and the balance thereby attains the position shown by the figure. The three-way cock is also reversed by this motion.

Thus, as already described, the water current is now cut off, the water present in M flows out through K^2, and the mercury goes back from the pump, Q, into the ball, H.

During the tipping over of the balance, however, the sliding weight, C, has run down its inclined plane to a ledge, E, so that it now exerts a pressure on the lever arm. Its momentum is so calculated that the mercury in the pump must have fallen to the point, p, and flowed back into the ball, H, before it again overweighted, and moves back the balance. The weight, C, then slides back again to the left until it rests against its left ledge, and the play of the pump recommences. It will easily be seen that the height to which the mercury rises in the pump, the mass of the sliding weight being a constant quantity, depends only on its final positions, and that, therefore, the adjusting of the height of the mercury can be easily and accurately done up to a centimeter.

It goes without saying that every mercurial air pump not provided with cocks can be worked by the apparatus just described. But the improved construction of the Toepler pump, drawn likewise in projection in the figure, has proved to be especially practical. The following is a description of its automatic working:

If the cock, t_1, is connected with an hydrostatic air pump, the ball, Q, of the pump and the space, R, which is to be evacuated through the tube, S, is pumped out up to the tension of the vapor. The mercury then rises in the tube, R, almost to the height of the barometer above its level in the ball, H. If the automatic apparatus is then set in motion, the mercury enters the ball, Q, and the tube, S, thus cutting off the connection with R, while any further rising of the mercury in the tube, S, is prevented by a glass valve, v, it passes through the first V-tube, r_1, filling the little vessel, r_2, and rises through s_1 into the ball, n, driving before it the air which was before shut off in Q. At this moment so much mercury has been forced out of the ball, H, into the pump, Q, that the balance is turned, the mercury flows back out of Q into H, forming vacua in r_2 and Q, as the little mercury threads remaining in the side tubes, r_1 and s_1, form shut-off valves. As soon as the mercury has fallen below the entrance point of S into E, the pressure in R and Q becomes equal, the denser air flowing out through S into Q. The time during which Q is connected with R may be determined at will by changing the right ledge of the sliding weight. Then the balance again changes its position, the mercury rises in V, and so on. When the pump has made a few strokes in this manner, a lever, T, is let down so as to rest on the ledge, u. The wheel F, provided with six pegs, is now turned a tooth farther each time the weight, C, slides from the left to the right, and the ledge peg, f, which when the lever was raised caught each time into a notch of the peg wheel, rests for the length of five strokes of the pump against the circumference of the wheel, and does not catch into the notch until the sixth stroke. As the rising of the quicksilver in the pump is in the inverse proportion of the momentum of the counterweight in its left final position, if the ledges and peg, f, are rightly placed, it will when ascending be driven five times into the little hollow space, r_2, and only at the sixth into the ball, n. In consequence of this the little air bubbles are accumulated in the highly evacuated space, r_1, in which they ascend owing to the slight counter pressure, and forming larger bubbles, and having easily overcome the somewhat greater counter pressure of the mercury column, s_1, they rise into the ball, P.



AUTOMATIC MERCURIAL AIR PUMP.

All these manipulations are performed *entirely automatically* by the apparatus. At the same time that the toothed wheel has commenced working (*i. e.*, when the volume of air pumped out by the pump has sufficiently diminished) the vessel, P, is entirely cut off from the hydrostatic air pump by the cock, t_1, thus ceasing to act. The mercury of the pump is entirely shut off on *both sides* from the exterior air, and only in contact with perfectly *dry* air. After stopping the pump, concentrated sulphuric acid may be sucked up into P, which dries up entirely. The mercury is shut off from M by a caoutchouc bag, I.

The following experiments were made at the Physical Institute of the University of Berlin.

400 c. cm. (cubic centimeters) were evacuated to 1/1000 mm. in ten minutes; 4,000 c.c m.=4 liters in an hour.

The highest rarefaction hitherto obtained has been about from 1/600,000 - 1/800,000 mm. = to about $\frac{1}{456000000}$ — $\frac{1}{608000000}$ atmospheres.

The pump is supplied by Messrs. E. Leybolds Nachfolger, Cologne (Germany).—*Nature.*

BAGASSE AS A FUEL.*

THE value of bagasse as a fuel depends greatly upon the percentage of juice extraction, and also upon the construction and equipment of the furnace in which it is consumed. By equipment is meant the mode of admitting the bagasse, the type of boiler used, the amount of heating surface exposed and the supply of air in proportion to the quantity of bagasse to be utilized.

In order to estimate the value of bagasse as a fuel, there must be established as a standard some fixed percentage of extraction, which in this instance we will assume to be 75 per cent. Basing our calculations upon this hypothesis, we find three pounds of bagasse to be equal in value to one pound of coal, if consumed in a furnace of suitable construction properly equipped.

Admitting the foregoing, it is easy to determine the proper proportion of burner, the square feet of grate surface and the amount of air necessary to effectually and efficiently consume a given weight of bagasse per hour.

In a house grinding say 400 tons of cane per day, there will result therefrom 100 tons of bagasse, equal in value to 270 barrels of coal, or eleven and one-quarter barrels per hour, which would require a burner having a grate surface of 175 square feet, and an air supply of 416,666·5 cubic feet per hour at a temperature of 60° F.

Since the consumption of this quantity of bagasse is accomplished without additional expense, it may be set down as a clear gain of 270 barrels of coal per day. Therefore the burning of bagasse and its utilization as a fuel is a question of great importance to planters, and may be made when suitably applied a source of great economy.

* From a paper by Mr. A. F. Slangerup, read before the Louisiana Sugar Planters' Association, January 12, 1893.

THE ELECTROLYTIC BLEACHING OF COTTON AND WOOLEN FABRICS.

By H. N. WARREN.

So termed electrolytic bleaching, or in other words the employment of chlorine evolved during electrolysis, is now somewhat largely employed. Not that chlorine possesses superior bleaching properties when so evolved, but on the other hand retains, on account of its nascent origin, far more destructive properties with regard to its action upon vegetable tissue.

Solutions containing chlorides are not, however, the only available baths that can be employed as bleaching agents: for, if acidulated water tinged red by the addition of a small quantity of a solution of litmus be electrolyzed by a feeble current, after the lapse of a few moments the solution will have become entirely colorless. By enlarging the platinum electrodes, and employing a current of four volts, a weak solution of indigo may be also speedily rendered colorless.

After various experiments the author has used to the best advantage electrodes composed of compressed slabs of graphite rendered sensitive by subjecting them to an elevated temperature in a non-oxidizing atmosphere; having previously saturated the same with a concentrated solution of platinic oxalate.

The decomposing trough employed by the author was made of porcelain slabs of convenient dimensions, the bottom of the trough being furnished with two prepared graphite electrodes, the same being separated from each other by a non-conducting medium, and furnished with outward connections for establishing electrolytic contact when required. A similar trough to the above described, and capable of containing about 200 gallons of acidulated water, was experimented with, employing an electromotive force of 500 volts, the articles subjected to the bleaching action of the same being composed for the most part of indigo dyed cotton and woolen fabrics, which, upon examination of the same at the duration of about 30 minutes, as regards the cotton, had become entirely destitute of color, while those composed of the more refractory tissues (such as wool) had assumed a decided reddish tint, requiring several hours' action to remove the same. In future experiments, however, the same quantity of fabrics were successfully bleached in half the time by employing a temperature of about 80° to 100° Fah., whereby the hydrogen peroxide that is formed during the electrolysis is at once decomposed, thus accelerating the bleaching action. At present, however, there is (regarding this mode of bleaching) a considerable amount of uncertainty, which requires further investigation. When this difficulty has been overcome the process appears to be a most promising one as a bleaching agent, no difficulties arising from the destructive action upon the tissues, as is observed only too frequently in the case of chlorine.—*Chem. Trade Jour.*

POINTS OF CONTRARY FLEXURE—GRAPHIC DETERMINATION.

By Prof. C. W. MacCord, Sc.D.

In Fig. 1, let T T be tangent to the curve A B at P, the point at which the direction of the curvature changes; also let the radius of curvature constantly increase in going from either A or B toward P, at which point it becomes infinite. In these circumstances P is called a point of inflection, or of contrary flexure; and its precise location is, in mathematical treatises, usually determined, as is also the center of curvature for any other point, by means of analytical operations performed upon the equation of the curve.

These operations are often abstruse, and the reasoning is to many obscure; whence the writer was led to present these matters in a different manner and to show, in a series of articles which have appeared in the Scientific American Supplement, that the radius of curvature may, in the case of many of the higher plane curves, be determined by simple geometrical constructions.

The location of a point of inflexion is not so easy a matter, but the object of this paper is to show by a single illustration that similar reasoning may be employed in this problem also.

The fundamental idea is kinematic; regarding the normal as a moving line, a fixed point upon which traces the curve under consideration, the center of curvature is that point upon the normal about which that line is at the instant rotating. Thus in Fig. 2, let P N be normal to the curve M R; let P be moving with velocity P T, the direction being necessarily perpendicular to P N; and at the same instant let the point A have the motion A B. Resolve A B into the components A E along the normal, and A D perpendicular to it; then the perpendicular motions P T, A D, determine a rotation of the normal about C, the intersection of T D produced, with P N; and P C is the radius of curvature at P.

It is apparent that the more nearly equal P T and A D are, the more remote will be the intersection C, and that if they be exactly equal, T D will be parallel to P N, the normal will have a motion of side translation only, and the radius of curvature will be infinite. This may occur even if the curve is not one of contrary flexure; but if it be such, the region in which the direction changes can usually be approximately located, often by mere inspection; and in that case the normal at the point of inflection is the only one in that region which can have such a motion of translation.

Now in Fig. 3, let V be the pole, N N the axis, L L the directrix, and V B the generatrix, of a conchoid. Draw through V a perpendicular to V B, and through B a perpendicular to L L, locating the instantaneous axis A of the generatrix. The path of A is a parabola of which N N is the axis, and V the vertex (see Scientific American Supplement, No. 884); and the prolongation of T A tangent to this parabola is the direction of A's motion at the instant. Draw A C perpendicular to T A, cutting L L at C. On A C as a diameter describe a circle which will pass through B; produce V B to cut the circumference in D, and draw D C, which is perpendicular to D A.

The point B moves along the directrix L L, and we may assign to it any velocity B E; then drawing at E a perpendicular to L L, cutting T A produced in *c*, we have A *c* the absolute motion of the instantaneous axis. Describe a circle on A *c* as a diameter, produce B A to *b*, D A to *d*, and draw *b c*, *d c*, which are respectively pependicular to A *b*, A*d*. Produce A E to H and *h*, and draw *h c* cutting A *b* in *e*. Make the angle D A G equal to the angle B A E, draw A G cutting D C in F, produce it to *g*, and draw *g c* cutting A *d* in *f*. Then the triangles A B E, A D F, *c b e*, *c d f*, are all similar, and we have

$$\frac{\mathrm{B\,E}}{\mathrm{D\,F}} = \frac{b\,e}{d\,f} = \frac{b\,c}{d\,c}. \quad \text{But } \mathrm{B\,E} = b\,c, \therefore \mathrm{D\,F} = d\,c.$$

Hence, *c* F is parallel to D *d*; also, it cuts the circumference of the upper circle at *x*, and A *x* is equal to *d c* and therefore to D F.

Now, let D on the generatrix V B produced, be the tracing point of a conchoid, then D A, passing through the instantaneous axis, is normal to the curve. The angular velocities of B and D around A being equal, D F is the absolute motion of D; the absolute motion of A, a point on the normal, is A *c*, of which the side component A *x* is equal to D F, as just shown: the radius of curvature is therefore infinite, and D is a point of contrary flexure.

The above operations, it will be noted, are purely geometrical; for, it having been established that the path of the instantaneous axis is the parabola V A Z, the tangent at any point A is readily determined without drawing the curve, by the familiar property that the subtangent is bisected at the vertex. Thus, drawing the ordinate A R, set off on the axis V T equal to V R, then T A is the tangent required. And by these operations we are enabled to locate, upon the generatrix occupying a given position, a tracing point which at that instant coincides with the point of inflection of its conchoidal path, which, the constant distance B D being thus determined, is readily drawn in the usual manner.

But if this distance B D is assigned at the outset, a different situation is presented; the curve may be drawn as before, and it is quite obvious that the direction of the curvature changes somewhere between X and Y: but the converse problem of determining the position of the generatrix V B does not appear susceptible of solution by simply geometric processes.

However, a solution involving graphic operations only may be effected, the basis of which may be explained by the aid of Fig. 3. In that diagram, the center O of the circle whose circumference passes through A, B, and D must lie upon a perpendicular to the chord B D at its middle point P. The same center O also bisects that portion A C of the normal to the parabola V Z at A, which is intercepted between the parabola itself and the directrix L L of the conchoid. We may then proceed as follows: Having drawn the parabola, place the generatrix of the conchoid in any position at pleasure, find the instantaneous axis, draw the normal to the parabola at that point and bisect the intercept, as above explained. Draw also a perpendicular to the generatrix at the middle point of the given constant distance (corresponding to B D), and find its intersection with the same normal to the parabola. Repeat this construction with the generatrix in various positions: the points of bisection first mentioned will determine one curve, and

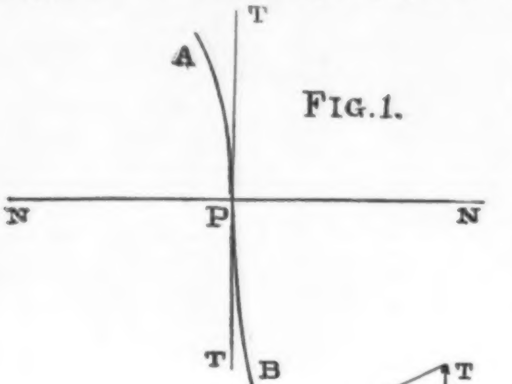


FIG. 1.

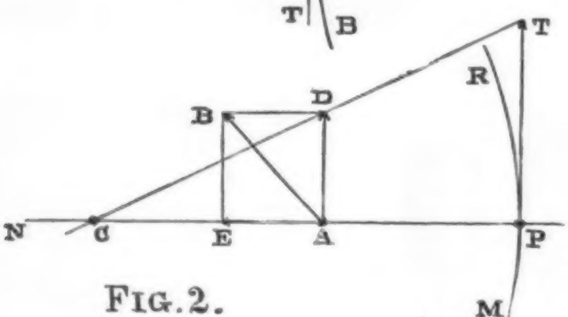


FIG. 2.

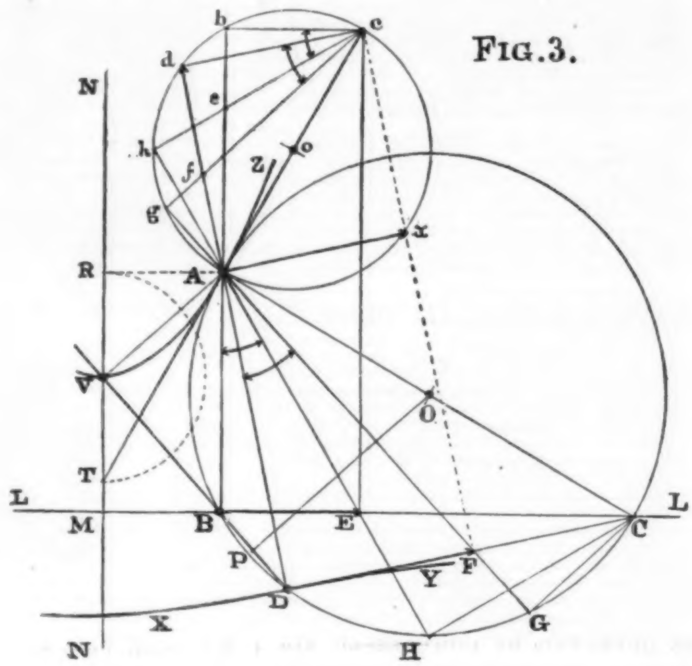


FIG. 3.

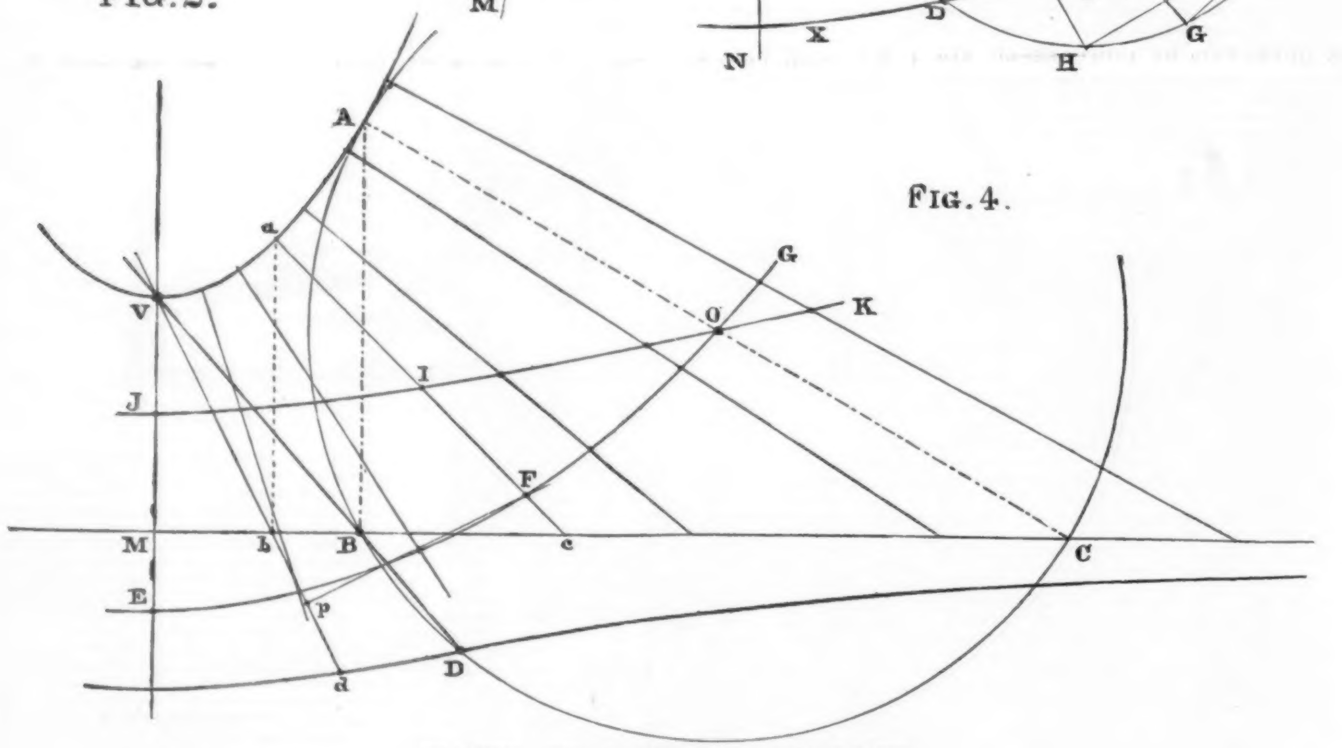


FIG. 4.

POINTS OF CONTRARY FLEXURE.

the points of intersection last named will determine another. Then these two curves will cut each other in the required center O, about which point describe a circle tangent to the parabola: the circumference will cut the conchoid in the point of inflection. The construction in accordance with the above is shown in Fig. 4, where J I K is the first, and E F G is the second, of the auxiliary curves described; the rest of the diagram being lettered to correspond with Fig. 3, no further explanation is required.

It may be remarked that had the conditions in Fig. 3 been differently selected, the generatrix V B might have cut the circumference of the lower circle, at a point above B. This however would not affect the argument, as will be evident when it is considered that a tracing point so situated would describe a conchoid, which like the one below L L would have a contrary flexure, provided that the distance from B to D were less than the distance M V of the pole from the directrix. It may be added that practically it is unnecessary to construct more than small portions of the auxiliary curves, since, in most cases at least, the position of the point of contrary flexure can be located within quite narrow limits by inspection.

SHOPS OPERATED BY COMPRESSED AIR.

AT East St. Louis there is a manufacturing plant that is the most notably interesting that it has been our fortune to visit—interesting not so particularly because of design, great extent or enormous output, or because of special processes or methods, but because of the fact that the sole power employed in working the various tools is compressed air. As far as we know, this plant is the first and only shop in this country which uses air exclusively for power.

For several years past compressed air has been used for various tools, but a shop plant in which all tools and appliances, from a 20 ton crane to a small tool grinder, are operated by air is a decided novelty.

The plant where this is done is that of the Wuerpel Switch and Signal Company, located, as above stated, at East St. Louis. Mr. Wuerpel has had long experience with compressed air in connection with his signaling and interlocking work on the St. Louis bridge tunnel and terminals. In the small shops of the bridge and tunnel company there have been for some time a number of tools operated by compressed air on plans designed by Mr. Wuerpel.

In the works of the Wuerpel Switch and Signal Company, which were erected last summer, all operations incident to the manufacture of the various parts used in the Wuerpel interlocking signal system and of the Wuerpel steam wrecker (aside from the operations of casting) are handled by compressed air power.

In our engravings, Fig. 1 shows the floor plan of the machine shop (the location of the air piping and of the various tools being indicated by figures); Fig. 2 gives a ground plan of the entire plant; Fig. 3 a floor plan of the power house.

Power is supplied to the entire plant by a compound Norwalk compressor rated at 55 horse power. The air is stored in a reservoir just outside the power house, and is piped thence (beneath the ground) to the machine shop and to the pattern shop. The piping in the machine is overhead and serves each tool directly, except at the lower end of the shop, where a number of the smaller tools, lathes, drill presses, etc., are grouped and are served through a smaller set of line shafting.

In all other cases it will be noticed that each tool has its own engine, located immediately at its base or at a contiguous wall. With the exception of the engine used to run the line shafting for the small tools, all the engines in the machine shop and pattern shop are of the Kriebel make, ranging in rated power from 2 to 8 horse power.

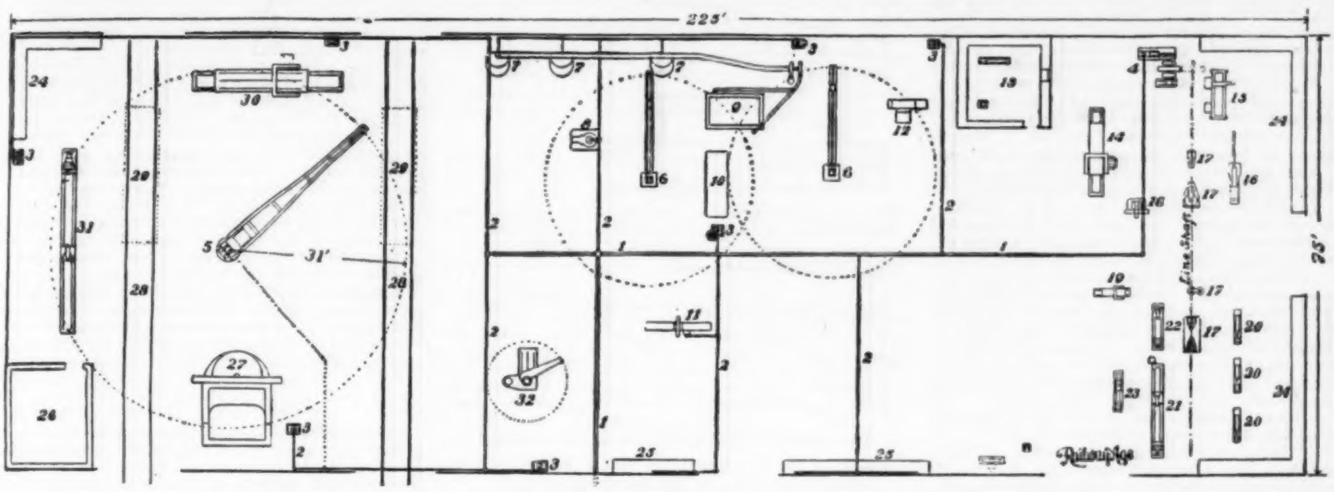
It will be noted that the shop is well equipped for its purposes with modern tools. The 20 ton power crane (operated by air) is home made and is strong, efficient and cheap. It is needed for the heavy work on the Wuerpel steam wreckers, two of which interesting machines are just about to be turned out. We expect to very soon illustrate these wreckers. There are also two hand cranes serving the power hammer, bulldozer, heating furnace, etc.

It is estimated that the saving in the operation of this plant effected through the use of air for power is from 15 to 20 per cent., although no actual figures have as yet been collated. It will at once be perceived that under this system tools can be placed exactly where wanted, regardless of the usual limiting conditions introduced by the use of line shafting. This insures under proper management economical methods of handling material from the rough to the finished state.

The absence of line shafting, with its heavy draught upon power and its expensive maintenance, insures another element of saving. There will be no waste of power, for the simple turning of a cock starts up an engine and its tool; and the moment the particular job is finished, turning back the cock instantly stops the draught upon the power supply. The tools are always ready at instant command, but become idle and cease eating up coal the moment they have performed their service. The initial cost of the power plant, including cost of the engines at each tool, was about equal to the cost of an ordinary steam plant, including line shafting, etc.

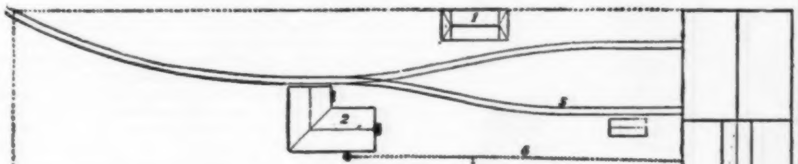
These shops are well lighted and ventilated, the ventilation (as well as cooling in summer) being materially aided by the constant discharge of air from the exhausts of the various engines. The shops cost about $70,000 all told, including the ground. About 100 men have been employed, and the force will probably be 150 in March, although not running on this basis just now.

The shops are operated by the following staff: M. Wuerpel vice-president and superintendent; F. A. Lapham, general manager; M. Wuerpel, Jr., superintendent of erection; George Ross, electrician; O. H. Jackson, general foreman; C. N. Macfarland, chief draughtsman.—*Railway Age.*



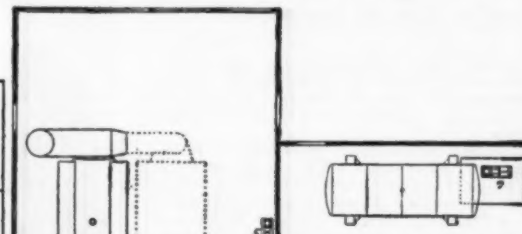
1. Main Air Pipe; 2, Branch Pipes; 3, Engines for Large Tools (Kriebel); 4, 6x14 Engine for Small Tools; 5, Power Crane; 6, Hand Cranes; 7, Forges; 8, Hammer (Morgan Engineering Co.); 9, Oil Furnace; 10, No. 5 "Bull Dozer" (Williams, White & Co.); 11, Punching and Shearing Machine (No. 2), Long & Alstatter Co.; 12, Cold Saw (Newton Machine Tool Works; 13, Tool Room; 14, 30x30 Planer (Niles); 15, Shaper (Niles); 16, Horizontal Boring Machine (Niles); 17, Drill Presses; 18, Milling Machine (No. 2 Brainard); 19, Jumper (C. Whitcomb & Co.); 20, Lathes, 14 in. 6 ft. bed (Flather & Co.); 21, Lathe, 24 in. 16 ft. bed (Lodge, Davis & Co.); 23, Turret Lathe (Lodge, Davis & Co.); 24, Benches; 25, Testing Benches; 26, Stock Room; 27, Boring Mill (Niles); 28, Tracks; 29, Pits under Tracks; 30, 50x50 in. Planer (Niles); 31, Bending Roll; 32, Radial Drill (7 ft. Radial, Niles Tool Works).

FIG. 1.—WUERPEL AIR-OPERATED SHOPS.



No. 1, Offices; No. 2, Air Compressor and Light Plant; No. 3, Pattern Shop; No. 4, Machine Shop; No. 5, Tracks; No. 6, Air Pipe to Machine Shop; No. 7, Air Pipe to Pattern Shop.

FIG. 2.—WUERPEL SHOPS—GROUND PLAN.



No. 1, Boiler (John O'Brien Boiler Co.); No. 2, Steam Pipe; No. 3, Compressor (Norwalk); No. 4, Light Plant; No. 5, Feed Pump; No. 6, Water Tank; No. 7, Pump; No. 8, Air Receiver.

FIG. 3.—WUERPEL SHOPS—POWER HOUSE.

CORDITE.

LIKE other smokeless powders, cordite has hitherto been kept dark by the authorities, but the time is coming when it must be well known. It has for a considerable time been manufactured in large quantities at Waltham Abbey, and has been under experimental trial in our remote colonies. At the present moment, if war were to break out, we do not doubt that it would be largely issued with quick-fire guns, whose efficiency practically depends on it. How long the issue is delayed depends probably on the solving of difficulties as to details in arranging for storage and supply. Captain Noble has now called public attention to the remarkable powers of cordite, and it is high time to give our readers a short account of it. Although still reticent on the subject, our authorities recently sanctioned the reading of a paper at the Royal Artillery Institution, Woolwich, on cordite, by Colonel Barker, R.A., late superintendent of Waltham Abbey, and the last number of the United States Annual of the Office of Naval Intelligence calls special attention to this substance.

Before dealing in detail with cordite in any sense, we would point out in the most general terms the properties which render it specially valuable. (1) It is smokeless, and hence enables quick fire to be kept up without losing sight of the mark, and therefore to be aimed without interruption. (2) It has remarkable ballistic powers, enabling a projectile to be discharged with any given amount of energy with much less pressure on the gun than would take place with black or brown powder. (3) It is much stronger than powder, and is, therefore, used in much smaller bulk, which gives advantages which would not at first, perhaps, occur to the mind, such as the decrease of powder chambers, and in certain cases the decrease of bulk in breech fittings, which become lighter and more easily manipulated, while the breech of the gun is strengthened. (4) Cordite is very safe and convenient to handle and use generally. On the advantage of absence of smoke it is needless to say much. Quick-fire guns, we all know, first came in as a reply to torpedo attack. And good aim is required in repelling torpedo boats, seeing that the mark is very small and moves very rapidly. The cutting about of the upper structure of ships is only effectually done by well aimed shots. The conning towers and their communication, the bases of large military masts, and other objects on which quick-fire guns would be directed are small targets, and in many cases "a miss would be as good as a mile." It is a great matter, then, to secure the power of the marksman keeping his eyes on the sights almost without interruption while keeping up a stream of fire from his gun. The statement that a projectile can be discharged with energy disproportionate to the pressure on the bore, as it appears to be, when com-

pared with the case of powder, at first provokes suspicion. "Action and reaction are equal," we may find ourselves saying. Any work done on the shot in one direction must be performed on the gun in the opposite direction. This lower pressure means a lower maximum, but the energy is got by prolonging this pressure toward the muzzle. Such pressure, no doubt, is little for the breech to bear, nevertheless the forward part of the gun may not be able to sustain it, so that we may have our guns again yielding at the muzzle. It must be explained, then, that there is absolutely much less work to be done in the case of cordite than with powder. A considerable part of the products of combustion of powder are liquids and solids possessing inertia; consequently, it is necessary not only to project the shot, but also a mass of heavy products of combustion. The products of the explosion of cordite are, on the other hand, all gaseous and possess little inertia, so that it is only necessary to overcome the inertia of the projectile itself, and thus, other things being equal, the gun performs much less work in projecting a shot when fired with cordite than when fired with powder. There is a curious fact connected with cordite which we suggest may be the result of this, namely, that the firing of blank ammunition causes no report. May it not be that the report is due to the projection of some mass possessing inertia? Thus, in the case of powder, either a projectile and also a mass of products of combustion or, in the case of a blank charge, a mass of products of combustion, is driven forward. In the case of cordite, when a shot is fired the same report is caused, but with blank cordite there is nothing heavy projected, and there is no report. The advantage in decrease of bulk may be realized when it is remembered how very large our charges of powder had become. Hence it happens that in one case where a piece had an enlarged chamber, the adoption of cordite enables the chamber to be brought to the size of the bore, and the breech fittings reduced in weight by one-half, while, as already said, the gun is greatly strengthened. Lastly, to come to the handling and use of cordite. It is well to explain what cordite consists of. The composition of cordite is described as follows in the application of Sir F. A. Abel and J. Dewar, dated April 2, 1889, for a patent relating to the manufacture of explosives for ammunition from blasting gelatine or its compounds: "This material, made in the usual way, but with a greater percentage of nitro-cellulose, and with sufficient solvent, such as acetone or acetic ether, to produce a moderately thick jelly, or ordinary blasting gelatine, to which soluble nitro-cellulose and solvent have been added, is pressed through holes of various sizes so as to form a number of wires. When the latter have become toughened by evaporation of the solvent, they are cut into lengths, which are packed side by side in the shells or cartridge cases. The rapidity of combustion increases as the diameter of the wires is diminished."

The mixture of a solution of gun-cotton with nitroglycerine presents the strange phenomenon occasionally met with of ingredients becoming much safer to deal with when combined together. So safe to handle, indeed, is cordite, that it is held in the hand and lit like a wax taper to show how it burns when unconfined, and all sorts of tricks are played with it. The keeping qualities are the next consideration. On this the United States Intelligence report states that in Canada and in tropical climates the keeping qualities of cordite have been severely tested. Under some extreme conditions of heat we are informed by the United States report that its explosive force increased largely, and in extreme cold a slight liquefying of glycerine took place, although it was not considered by some as affecting its serviceability. Exposure to sun does not affect it. With our tropical colonies this investigation will doubtless be pushed to exhaustive lengths, but we imagine that the issue of cordite to small arms and our most important quick-fire guns cannot be long delayed. Before it is applied to full advantage to our heavy ordnance, Captain Noble appears to anticipate almost "a reconstruction of artillery."—*The Engineer.*

RESPIRATION IN SINGERS.

The theory of phonation is one of the most delicate ones of physiology. Despite the laborious researches and the interesting discoveries made by numerous eminent savants, the problem of the emission of the voice and of the mechanism of singing remains passably obscure.

We know that the apparatus of phonation is nothing more than an organ pipe. The lungs and the trachea play the part of the bellows and wind canal; the larynx is the generator of sound, the vocal cords playing more particularly the part of the reed; and finally, the vocal pipe is formed by the pharynx, the mouth and the nasal fossæ. Mr. Demeny, preparator to Mr. Marey, professor at the College of France and chief of the laboratory of the physiological station at Auteuil, has endeavored to find out how the air stored up in the lungs is expired by the singer, and what muscles intervene in the emission of protracted sounds.

It was to be anticipated, by assimilation of what takes place in organ pipes, that the expiratory muscles, placed, as we know, in the abdomen, and which act by exerting a pressure upon the lungs, must intervene only in a secondary manner in singing. If, in fact, we increase the pressure of the air stored up in the bellows of an organ, the sound emitted by the pipes, far from becoming more powerful, is converted into a sort of disagreeable whistling. An analogous phenomenon occurs when persons who do not know how to play the trumpet or French horn blow with vigor into the instrument. Instead of the sounds expected, we hear merely loud noises that are scarcely harmonious. Finally, whoever has observed a singer has been easily able to see that the abdomen remains very perceptibly immovable during the emission of a note. The previsions have been verified, and Mr. Demeny, who has made experiments on a certain number of known singers, has found that, in singing, the expiratory muscles remain nearly inactive.

Mr. Demeny has observed in the first place that the pulmonary capacity of singers is large. While the normal pulmonary capacity is about 180 cubic inches, it is in singers rarely less than 240, and often reaches 366. That of Mr. Dubulle is 365 cubic inches, and that of Mr. Giraudet 275.

This increase of the volume of air that can be stored by the lungs proves that singing is a true and excellent gymnastics. Let us add, however, *apropos* of this, that it must not be supposed that, because the pulmonary capacity has nearly doubled, the volume of the thorax has also doubled. Such is not the case; the thoracic cavity has simply been better utilized.

In order to study the mechanism of the discharge, during the emission of a protracted sound, of the air stored by the lungs during an inspiration, it was necessary to determine three elements: (1) The quantity of air emitted during the duration of the sound, and the manner in which the emission was produced; (2) the motions of the thorax; and (3) the motions of the abdomen.

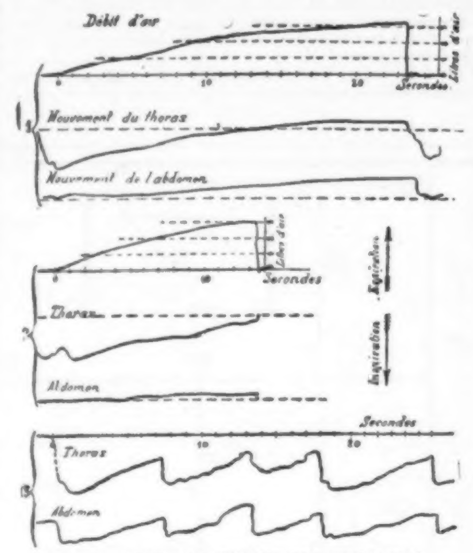


Fig. 1.—RESPIRATION IN SINGERS.

Diagrams of the respiration of Mr. Dubulle (1), of Mr. Giraudet (2), and of Mr. Boudouresque (3).

The quantity of air discharged is measured by the spirometer (Fig. 2). This apparatus is a simple gasometer—a large cylindrical vessel containing about 12,000 cubic inches of air. If one blows into this gasometer, the air that is introduced into it increases the primitive pressure, and from the increase of pressure indicated by a water manometer is deduced, by elementary application of Mariotte's law, the volume of air breathed in. If this manometer be connected with a registering apparatus, we shall obtain a curve that indicates not only the volume of the air expired, but the manner in which the expiration is accomplished.

The motions of the thorax or of the abdomen are studied through the pneumograph. The apparatus is fixed upon the thorax, for example, follows the motions of it, and transmits them to a registering apparatus which inscribes them. The pneumograph consists essentially of a rubber capsule, the internal air of which is compressed or dilated, according as the thorax upon which the capsule is fixed expands or contracts.

Fig. 2.

A, clasp of the pneumograph; B, pneumograph; D, registering apparatus; E, tube for transmitting the oscillations of the pneumograph; F, spirometer; G, water manometer.

If, then, we wish to know the manner in which a singer prolongs a sound, we fix a pneumograph upon his thorax, and another upon his abdomen, and ask him to give his note in the spirometer. This experiment has been repeated a number of times by Mr. Demeny, and we herewith show our readers some of the curves that he has obtained. If we examine these, we find that when Mr. Dubulle (Fig. 1) gives the normal *la*, or when Mr. Giraudet gives the *sol*, the motions of the abdomen are almost null, at least at the beginning of the expiration, while those of the thorax are, on the contrary, noteworthy, and the two curves representative of the discharge of air and of the motions of the thorax are sensibly parallel; whence the conclusion that expiration in the case of a prolonged sound is regulated almost solely by the thoracic muscles.

These diagrams are instructive from other points of view. We find, in fact, that the discharge of air is represented by a straight line, which signifies that when a singer prolongs a note the air is expired regularly. Mr. Dubulle, for example, gives the normal *la* for twenty-four seconds. He expires about 200 cubic inches, and during every second the quantity of air expired is the same. At the twenty-fourth second the artist has to inspire, and the line becomes abruptly a vertical. The diagram figurative of the motions of the thorax shows that the artist, before emitting a note, takes a deep inspiration, represented by a strong inflexion of the curve, which rises during the period of the expiration, and becomes inflected anew when another inspiration takes place.

So, too, when Mr. Giraudet gives the *sol*—a note that he holds for fourteen seconds—he discharges 180 cubic inches of air, and we find, what is entirely special to this singer, that the motions of the abdomen are null.

The curious theory that Mr. Demeny has established as a consequence of his experiments is not always rigorously verified, since singers do not all manage their voices in the same way. Thus, diagram 3 of Fig. 1, which gives the motions of inflation and depression of Mr. Boudouresque's thorax and abdomen while singing the air of the nuns of Robert le Diable, shows the almost perfect parallelism of the two representative curves. It must be concluded from this that when Mr. Boudouresque sings, what we have said of the relative immobility of the abdomen ceases to be true. The experiments that we have just described are none the less very interesting, and are worthy of being resumed and developed.—*Magasin Pittoresque.*

INNOCUOUS WHITE LEAD.

The difficulty of avoiding the occurrence of lead poisoning among those employed in the manufacture of white lead by the old process is too well known to need special reference in these columns. The White Lead Co., Limited, who have a process for manufacturing innocuous white lead, threw open their works at Possil Park, Glasgow, recently for inspection in order to show the advantages of their process over the old one. A number of experts and reporters took advantage of this opportunity of visiting the works. The process was explained by the manager (Mr. Charlier), who, after apologizing for the absence of Sir Henry Taylor, said he would not waste time by detailing all the difficulties which the company had undergone in endeavoring to make their white lead a success; but desired, in a straightforward manner, to refer to the present process perfected up to date, and felt sure all present would agree with him that they had now succeeded in forming a pigment second to none in the white lead market. Spanish ore had on many occasions been used, but, as it contained silver, it prevented as good lead being extracted as was desired, and now English ore was used, which contained no silver. The bulk of this ore is generally sufficiently fine to be sublimed without grinding; it is, therefore, riddled and the large pieces are alone ground. Each barrowful is carefully weighed as it leaves the ore shed, the contents being made up to 2 cwt. When starting a set of furnaces they are lighted overnight, and are then generally in good order for charging early in the morning. No ore is thrown on until the fire is perfectly clear and free from all smoke and dark char, and the flues thoroughly heated. Charging is begun very gently, by throwing on a small shovel of ore, scattering it over the surface of the fire. At this time the foreman adjusts exactly the current drawn through the Kortings by regulating the steam, just enough being given to draw off all the fumes, so that none are lost. When charging is proceeding regularly no ore is thrown on until the previous charge has disappeared, as otherwise the fire gets choked and loses its heat. The fume passes from the furnace into the flue, where it meets a blast of air intended to complete the oxidation of any volatilized galena or coke dust. It passes through the main flue into a tower and into Korting blowers, which force it into the first box of the condenser. This condenser, though constructed of wood, is lined internally with fire brick, in order to resist the heat, which is so great that it at once chars wood. The fume, now mixed with steam, is forced under flies, and gains the second box of the condenser through a brick channel. In this box the flies are made of bricks, with vertical openings through which the fume is forced, a portion, of course, being condensed. In the second box the heat is not so great as in the first, and the wooden walls are simply lined with sheet brass. From the second box the fume reaches the third and last, which contains wooden flies with a much narrower aperture than in boxes 1 and 2. The three boxes are discharged into the washing vats about three times a week, and are then thoroughly washed with slightly acid water, to convert any oxide into sulphate. The product is further washed to free it entirely from acid, and then, after settling, it is pumped into presses, and subjected to a pressure of 90 pounds to the square inch. In these presses most of the water is got rid of, the product when removed from the press bags being a white cake, containing from 10 to 15 per cent. of water. These are then placed in earthenware pans in the drying rooms, and dried at a temperature of 120° F., and after this operation it is ready for the market. At the present moment there are 30 furnaces available for work, each one being capable of converting a ton of lead a day, or a total of 30 tons, being at the rate of 210 tons a week, or 10,000 tons a year. The white lead so produced is perfectly non-poisonous, and has no injurious effects on the men who make it, the grinders who grind it, or the painters who use it, and as a simple verification of this statement, he mentioned the fact that when a person is suffering from poisoning from carbonate of lead, diluted sulphuric acid is given as a medicine to convert the poison into non-poisonous sulphate of lead, which is the very pigment the company made.

As a practical verification of this statement, no one could point to a single case of lead poisoning among their workpeople. Their white lead did not discolor, nor was it affected by any gases of the atmosphere, and, while carbonate of lead quickly turns black, theirs remained as white as snow for years. It withstands the action of sea water, does not act chemically on metals, does not blister or crack, and is an effective anti-corrosive paint. It is also of great fineness and peculiar beauty, and much whiter than carbonate of lead. With regard to body, it has quite as much covering power as carbonate of lead, and he had every hope, from experiments made, that they would by a simple process soon give it a body far superior to the best Newcastle carbonate white lead. (Applause.) He had been told that this was impossible, owing to the lead sulphate not containing so much lead as the carbonate; but he contended that that theory was entirely erroneous, and that to make a perfect pigment it was not the quantity of lead that affected it, but the other elements in conjunction with the lead. Zinc oxide, for example, was a pigment greatly used in the trade; it contained a larger percentage of zinc than any other zinc compound, and yet had little covering power, whereas zinc sulphide had a far less percentage of zinc than zinc oxide, and yet had double its covering power. He contended that the same argument was applicable to lead.—*Chem. Tr. Jour.*

THERMAL STORAGE.

THE attention of electrical engineers has lately been directed by Prof. Unwin, in his Howard lectures, to the subject of the storage of energy, and particularly to its storage in the form of heated masses of water. The highly fluctuant load diagram shows the need of some reservoir in a central station wherein a surplusage of energy may be kept in readiness for use in times of great demand. By running the engines and boilers at full and steady load much more economical results can be attained than if their performance is made to follow implicitly the irregularities of the load line. With a reservoir of sufficient capacity the engine and boiler plant may be set to store the surplus energy during hours of light load, and may be run in parallel with the reservoir during hours of heavy demand. Such is the economic principle of storage. But the application of this principle involves difficulties. To whatever form of energy in nature or in artificial plant we turn for economic storage, we are met by the most deplorable losses, and sometimes by almost ruinous first costs. The principal modes of storing energy for practical use are as follows: Pumping water to a high level, fly-wheels, compressing air, raising masses of metal (as in clocks), coiling springs of elastic metal, dissociating chemical compounds (as in storage cells), and the method under our especial consideration in this paper, viz., thermal storage.

When a mass of water is heated to a temperature above 212° Fah., it must sustain a pressure not less than the pressure of saturated steam at that temperature. The relation between any given temperature of water and the pressure of the steam which it supports is given by Regnault in his famous table of the properties of saturated steam. If, then, a closed vessel, and one capable of standing the pressure, is filled with water at a high temperature, and if some of this water is drawn off into a space where the pressure is less than the pressure corresponding to this temperature, the water will immediately boil, and will develop steam at a rapid rate, until there is established over the surface of the water a new pressure which is in perfect correspondence with the temperature. For example, if an inclosed mass of water is raised to a temperature of 406° Fah., it will exert a constant pressure of 260 lb. per square inch, even though not a particle of steam exists in that space. But let us suppose that steam does exist in a part of that space, as it does in an ordinary boiler, and that a large amount of this steam is suddenly withdrawn by the engine. Instantly the pressure falls; but as it does so, the water evaporates into the steam space tending to keep up the pressure. Some of the heat becomes latent, by virtue of the change of state, and a fall of temperature takes place, the new pressure and the new temperature adapting themselves to a condition of equilibrium. If we assume the pressure to fall so much as to 250 lb. per square inch—an unusually large drop—then each pound of steam which would be produced would require on an average 830 thermal units. Now, the fall in temperature corresponding to the difference between steam at 260 and at 250 lb. is 3·4° Fah., so that each pound of water would give up 3·4 thermal units, and 244 lb. of hot water would be required for every pound of steam generated.

Examined in this light, it is seen that the problem of thermal storage is simply the problem of selecting a sufficient amount of *water room* in the boiler. This water room acts as a sort of fly-wheel, its thermal inertia carrying on the equilibrium of things when there is any sudden change in the demand for steam. It is interesting to note that this is what the problem really resolves itself into, for electrical engineers have been in the habit during recent years of decrying roomy boilers, and have been at great pains to show that the smaller the water room the better the boiler is adapted to their central station requirements. Moreover, it cannot be gainsaid that central station boilers are, as a rule, very much starved in the matter of water room. That a great mistake has been made in thus reducing the water space to the smallest safe figure we firmly believe, and the fact that hot water is so elastic a means of storage is in support of our conclusions.

In Mr. Druitt Halpin's scheme, described by Prof. Unwin, it is proposed to store water at 406° Fah., in steel cylindrical tanks, which would be supplied from ordinary boilers. From these tanks the steam would be drawn off through the main steam pipe at as rapid a rate as might be necessary to meet the demand. The result of this would be that the water would evaporate, would fall to 347° Fah., and would develop steam varying from 250 lb. down to 130 lb. pressure. The water would never be allowed to fall below this temperature, because steam at 130 lb. would be employed for working the engines, the steam being throttled down to that pressure when above it. The water at 347 Fah. would be reheated by the boilers and passed back again to the tanks. The whole plant is practically a large boiler or set of boilers, with plenty of water room in the form of auxiliary domes or drums.

As to the cost of this scheme as a system of storage, it compares very favorably with chemical storage cells. Prof. Unwin states that the cost of plant would be about £1·64 per British horse power with condensing engines, or £2·24 with non-condensing engines, as compared with £8 for battery storage. In regard to working costs, it ought not to be found very wasteful to keep a mass of water at this high temperature, provided ample lagging is placed on the outside of every hot surface. The efficiency would at any rate be as high as that of storage cells working with the same variation of output.

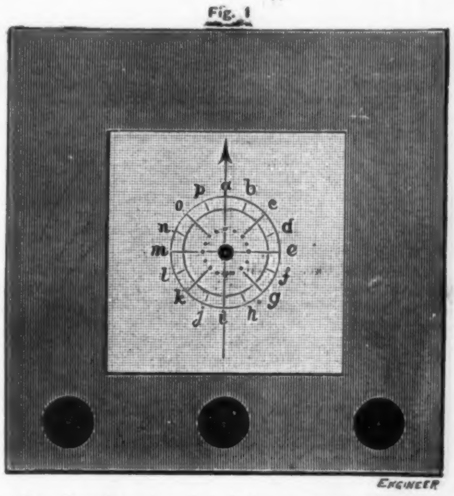
The extremely wide range of output which this system is capable of, and the rapidity with which it adapts itself to sudden changes in demand for power, would render it especially serviceable in those generating stations, such as tramway generating stations, where a change of several hundreds per cent. in the output may take place at a few seconds' notice. To cope with such extreme cases as these, all such means of storage as fly-wheels, quick-steaming boilers, secondary batteries or auxiliary engines are utterly unavailing. Possibly thermal storage may be found to be a successful solution of this great difficulty in electric power supply.—*Electrical Review.*

SENDING PLANS AND DRAWINGS BY TELEGRAPH.

AMONG the recent lectures at the Royal Institution, Mr. Francis Galton delivered one, in the course of which he dealt with the subject of sending plans and drawings by telegraph. The principle he adopted, says the *Engineer*, was to reduce outline drawings to an alphabetical formula, so that any one receiving the telegraphed letters of the alphabet could therefrom reproduce the outline drawings. He also entered into the question of expense in so doing. He said that the risk of error in telegraphing was small, for the meteorological office had found that in the telegrams of figures received from the Continent the errors were 2½ per 1,000 of the figures telegraphed.

Mr. Galton effected this by making a series of dots

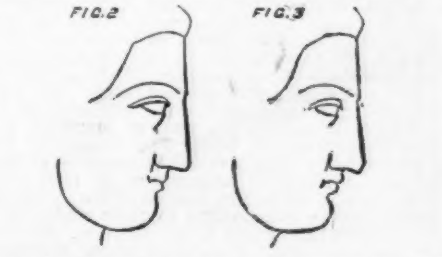
Fig. 1



of a line drawing at such a distance apart as to seem to the eye at a distance a continuous line, approximately or completely. Starting with one dot, the letters in the telegram showed where to place the other dots in succession in relation thereto. This was done by means of a "protractor," consisting of a rectangular piece of pasteboard, as in Fig. 1, with a rectangular orifice, in which was a piece of tissue paper. On the tissue paper was a circle, with some alphabetical letters placed round equidistantly in the positions of sixteen of the thirty-two points of the compass. This tissue paper had a large hole in the center, and sixteen smaller holes in the positions of sixteen of the points of the compass, as represented in the cut. The pasteboard itself had three large holes in it, which facilitated handling.

On receiving a telegram, consisting of a medley of alphabetical letters, the first step is to make a dot, and to bring it into the center of the central hole in the tissue paper. A second dot is then made in one of the little holes in the circle, corresponding to the next

FIG. 2 FIG. 3



letter in the telegram, and so on in succession. The protractor is always moved parallel to itself and to the edge of the sheet of paper. This is done by the aid of a T-rule, or by using a sheet of paper already ruled by faint lines, as in children's copy books. The upshot is, that a fairly accurate representation of the original drawing is reproduced. As drawings are not all in one continuous line, he employs "reference letters" to indicate where other lines branch off, or independent sections of the drawing to which each particular reference letter is adjacent.

Fig. 2 represents a Grecian head, the original of which was upon a large scale, and Fig. 3 represents the same head as reproduced by the alphabetical system. Both of them, in the cuts, are represented as photographically reduced from the original drawings. In the reproduced drawing, Mr. Galton drew a ring round each dot, then inked it in for photographic purposes, so as to make each dot conspicuous, yet without effecting its obliteration. Thus, in the original photographic reductions—Fig. 3—each dot is made of rings as seen through a lens, but owing to the exigencies of newspaper printing, these rings, as well as the dots, are lost, the whole appearing in the engraving as continuous lines. Still, the little cuts are faithful examples from photographs of what can be done in the way of telegraphing outline drawings.

Mr. Galton argued that with progress of time telegraphic communication will increase, and that in distant places events will occur which cannot be described but by pictorial illustration. Taking the case of this Grecian head, it was reproduced by means of 248 dots or letters, which, at 5s. per five letters—as charged by Atlantic telegraph for five figures—means £2 per hundred dots, or £5 for telegraphing the Grecian head. This, relatively to the large amounts now spent by newspapers in obtaining information, he did not consider to be excessive in telegraphing such a drawing to England from America.

THE FARMINGTON, WASHINGTON COUNTY, KAS., AEROLITE.

By GEORGE FREDERICK KUNZ and ERNEST WEINSCHENK, Ph.D.

ON Wednesday, June 25, 1890, at 12:55 central time, a roaring, rumbling sound was heard within a radius of one hundred miles around Washington, Washington County, Kas., and many observers noted a meteorite traveling from south to north, which in its course left a double trail of smoke. The sun at the time was shining brightly, and hence no light was seen. The explosion was likened by various observers to a bolt of lightning, the bursting of the boiler of an engine, or the report of a distant cannon. The largest portion of the meteorite, weighing 180 pounds, fell on the farm of Mr. W. H. January, who was greatly alarmed, as it struck very near him while he was under his wagon repairing it. This piece penetrated the hard shaly earth to a depth of four feet. Forty pounds of it were broken off and distributed before it was placed on exhibition, after which it was sold and resold several times, and now belongs to Prof. Henry A. Ward, of Rochester. Its dimensions now are 16⅛×16½×8 in.; weight 136 pounds. A distinct mass weighing nine pounds, now in the possession of George F. Kunz, was found on the farm of John Windhurst, and it is evidently this piece which made the second trail of smoke.

The sound was noticed throughout a number of counties, both in Kansas and Nebraska, as a thunderous roar, which at Clifton, twenty-five miles from the point of fall, was heard above the noise of a passing railroad train. The meteorite was seen over a much wider area even than its sound covered. Reports of observers are given from many places, ranging from Beatrice, Neb., 40 miles northeast of the point of fall, to Cedar Junction, Kas., 130 miles southeast, and Halstead, Kas., an equal distance south by west. To those north of the point of fall, it appeared as a brilliant object moving southward, while to observers south of that point its motion seemed northward. As Prof. F. H. Snow, who gives a full account of the circumstances attending the fall, remarks,* these facts indicate that its descent must have been not far from vertical, as is also shown by the nearly perpendicular hole, about four feet deep, which it made in the earth.

The actual fall was witnessed by Mr. January, as he came out from under his wagon alarmed by the extraordinary noise, and also by Miss Guild, a teacher in the Washington County Normal Institute, who was driving on the neighboring road, a hundred yards distant. Both came to the spot in a very few minutes, and Mr. January began promptly to dig for the object, and, with the aid of neighbors, reached its upper surface in an hour. But so firmly had it embedded itself in the shaly clay, that it was three hours before it was removed. When reached it was not hot. It had cracked into two portions, the smaller of which was the forty-pound mass broken up and carried away by the people of the neighborhood.

At the moment of its fall, the earth was thrown upward and outward for a distance of eight to ten yards or more.

The following analysis was made by Mr. L. G. Eakins through the courtesy of Prof. F. W. Clarke, chief chemist of the U. S. National Museum, Washington, D. C.

Approximate Composition of the Mass.		Analysis of the Iron.	
Nickeliferous iron... ...	7·7	Fe	86·76
Troilite..................	5·0	Ni	12·18
Siliceous part soluble in HCl	46·0	Co	0·83
Siliceous part insoluble in HCl	41·5		
	100·2		99·77

Analysis of the siliceous part from which all magnetic material had been extracted.

	Soluble in HCl. [1]	[2]		Insoluble in HCl. [3]	[4]
SiO_2	19·15	38·50	SiO_2	24·29	53·80
FeO	16·15	23·54	Cr_2O_3	0·64	1·41
NiO	0·34	0·69	Al_2O_3	1·95	4·32
CoO	tr.	tr.	FeO	5·41	11·98
MnO	0·17	0·34	MnO	tr.	tr.
CaO	0·06	0·12	CaO	1·84	4·08
MgO	18·31	36·81	MgO	10·10	22·37
S	1·97	.....	K_2O	0·12	0·27
			Na_2O	0·80	1·77
	56·15	100·00		45·15	100·00

Analysis No. 1 is the direct analysis of the portion soluble in HCl. Analysis No. 2 is calculated to equal 100. Analysis No. 3 the composition of the insoluble part. Analysis No. 4 calculated to equal 100.

The nickel-iron of this specimen shows, as is generally the case in stony meteorites, a higher percentage of nickel and cobalt than is usual in meteoric irons. The constituent in this stone, which was dissolved by hydrochloric acid, is shown by that fact to be olivine, in which the proportions of magnesia and iron are as three

* *Science*, July 18, 1890.

to one. The crust on this meteoric stone is black and dull, frequently over 1 mm. in thickness. Macroscopically the Washington meteorite resembles a doleritic lava, of dark gray color and splintery fracture, with white radiated chondri which protrude from the ground mass. The specimens also contain druses lined with crystals of sulphide of iron, the faces of which are rounded and present the appearance of having flowed through fusion, thereby rendering it impossible to measure the angles. No analysis of this material was made, although, from the total lack of oxidation, it might have promised good results.

Nickeliferous iron, which in the fracture is only slightly visible, becomes conspicuous on a polished surface, showing that it is present in many grains, some exceedingly minute, others up to 4 mm. in diameter. In one instance a vein 10 mm. long and 1 mm. wide penetrated the mass, and on the surface of a polished section appeared bright, serpent-like veins. The crust of the meteorite is black, hard, and uneven, and the surfaces, 0·8 mm. large, are dull and often of bead-like form. Under the microscope, the porphyritic character of this meteorite is readily recognized. Radiated and broken chondri and crystals of various minerals make up the microfelsitic ground mass.

All these are entirely enveloped in an opaque, evidently glassy magma, the dark shade of which gives the color to the whole. This dissolves in cold HCl, imparting a yellow tint to the acid. Heating to redness does not destroy the color, which fact surely precludes the idea of its being due to the presence of any organic matter. Prominent are crystals and fractured masses of olivine, which feature is of rather rare occurrence. This olivine is rich in orientated opaque inclusions, and has also a distinct cleavage, which is seldom observed in olivine. The optical character was, perhaps, disturbed through the rapidity of its crystallization.

Distorted undulation is common. Rhombic pyroxene is readily identified, frequently with a fibrous cleavage and monosymmetric augite; also the monticellite-like silicate described by Tschermak. The Washington County meteorite belongs to the black chondrites and has the greatest resemblance to the meteorite of Sevenkof. It is undoubtedly not a polygenous conglomerate, but was rapidly formed out of the fluid glassy magma.

The thanks of the describers are due to Prof. F. W. Clarke and Mr. L. G. Eakins, of the United States Geological Survey for the analysis, to Prof. Henry A. Ward for facts concerning his mass, and to Mr. Daniel Scheckler, of Washington, Kas., for obtaining one mass and information attending the fall.—*Am. Jour.*

CAREX JAPONICA VARIEGATA.

The figure is that of a pretty decorative species of Carex—a large genus of grass-like perennial herbaceous plants, few of which possess any horticultural value. The one under notice was shown by Messrs. J. Veitch & Sons at a meeting of the Royal Horticultural Society in 1889, and on that occasion it received a first-class certificate. A correspondent in Gloucestershire, who kindly sent the plant for our inspection, sent also the following particulars of his method of cultivating it: "Grown in 5 in. pots, it attains a height of 18 in. or 2 ft., and is a capital plant for room decoration, withstanding a dry atmosphere so well. As a plant for the dinner table, it is, in my opinion, second to none. The variegated variety is a particular favorite with us, and is as easily managed as the green variety. The plant is readily increased by division."—*The Gardeners' Chronicle.*

CAREX JAPONICA VARIEGATA.

THE DISCOVERY OF THE SEXUALITY OF PLANTS.

Attention was called, at one of the late meetings of the Brandenburg Society of Botanists, to the fact that the two hundredth anniversary of the discovery of sexuality in plants had recently occurred. It was, in fact, two hundred years since the doctor and botanist, Rudolf Jakob Camerarius, professor at Tübingen, separated two feminine types of the annual mercury from a group of plants of the same kind growing in a garden, and remarked that they had hollow seeds. His report on this subject, published in the Ephemerides of the Leopoldine Academy, is dated December 28, 1691. Camerarius demonstrated that plants are reproduced like animals by means of sexual organs. Till then confused notions had been entertained on the subject, and no one had thought of submitting it to an experimental test. Camerarius found that the stamens constituted the male organ and the pistils the female organs, and published the fact in his memoir *De Sexu Plantarum Epistola*. The thought, like many other great discoveries that are not appreciated at the time, was too remote from current ideas to be accepted, and was comparatively overlooked.

A hundred years after the discovery of Camerarius a book appeared that cast a new and living light on the question of the sexuality of plants. Like the elder one, it also was not appreciated by the students of the time. Although Camerarius had shown, between 1691 and 1698, the necessity of the intervention of the pollen in the act of the fecundation of plants, or the production of the seed; or, to use one of Goethe's expressions, that plants gave themselves up, in the bosom of the flower, to the sports of love, the special destination of the different parts of the plant remained a riddle.

But flowers, with their special properties, the richness of their living colors derived visibly from the green of the leaves, the wonderful variety of their forms and the perfumes with which they made the air fragrant, continued to attract the attention of the learned world. In 1793 a schoolmaster, the regent Christian Conrad Sprengel, of Spandau, again withdrew the veil, and showed with rare penetration, confining himself to the genus, what were the functions of the organs of the flower, and chiefly of the colored petals. The facts he disclosed, and which are now part of the incontestable patrimony of science, appeared so surprising to him that he entitled his book "The Mystery of Nature Unveiled in the Structure and Fecundation of Plants." He also advised the botanists of his time to study plants *in vivo*, in nature, instead of contenting themselves with the examination in their studies of dried and withered specimens in a herbarium. His discovery was of so great importance to the scientific explanation of the functions of the different floral organs that it is hard to explain how his book, still remarkable and interesting, could have passed unnoticed. Incredible as it may appear, it is nevertheless true that his ingenious work remained unknown till 1862, when Charles Darwin, being occupied with the same question, found it and made it known.—*Popular Science Monthly; Revue Scientifique.*

THE COLORING PRINCIPLE OF POKE BERRIES.

Several methods of obtaining this principle by precipitation were tried with negative results, but the following seemed to yield the purest product. The juice of the ripe berries was treated with an equal volume of alcohol and the mixture filtered after 24 hours. The filtrate after agitation with stronger ether was evaporated in a vacuum, the residue dissolved in 75 per cent. alcohol and filtered. The filtrate was evaporated under reduced pressure and yielded a bright purplish red powder. This powder was insoluble in absolute alcohol, ether, and chloroform, but was readily dissolved by water, yielding a bright red or purple solution, according to the strength of the solution. The aqueous solution was turned yellow by alkalies and reddened again by the addition of an acid.

On treating the aqueous solution with an excess of Fe_2Cl_6, or chlorine water, it was decolorized. The same result was obtained by strong oxidizing as well as reducing agents. Boiling the solution had no effect, but with the addition of HCl and continued heat, the solution was gradually decolorized. No change was caused by alum, cream of tartar, or stannous chloride; subacetate of lead produced a light purplish precipitate. An attempt to obtain the coloring principle by this reagent was a failure, due to the decomposition after separation of lead by hydrogen sulphide. On heating the aqueous solution with Fehling's solution, it gave an abundant precipitate of cuprous oxide. By previously heating with diluted acid, no increase in the reducing power on Fehling's solution was noted. An aqueous solution with a little alcohol has not been altered by exposure to sunlight for 14 days, nor has any appreciable amount of color been lost by exposing writing, in which it served as ink, to the same agent. Failures in preparing a permanent red ink from the berries have largely been due to the use of the impure juice, and here might be recommended a 2 to 5 per cent. solution of the coloring extract, preserved by the addition of 10 per cent. alcohol and 1 per cent. of glycerin. A solution of the coloring principle may be used as an indicator in the titration of acids; however, a rather strong solution must be used, and in most cases phenolphthalein is preferable.—*Am. Jour. of Phar.*

SACCHARINE.

An industry still young, but unquestionably with a great mercantile future, is that of saccharine, a product of coal tar. It is a substitute for sugar, has none of its bulk, and is so powerful that it is three hundred times sweeter. The history of its discovery is interesting.

In 1879 Dr. Constantine Fahlberg, a Russian by birth, but who had been educated in Germany, became connected with the Johns Hopkins University, in Baltimore. There he conducted a series of experiments on the toluene sulphamides, in order to investigate their oxidation products. The outgrowth of this investigation was the discovery of saccharine. By oxidizing pure orthotoluene sulphamide it was found that it would yield a remarkably sweet compound. The amount obtained, however, was too small to be of any practical value for manufacturing purposes. The problem thenceforth was to find other reactions which would give a better yield of the sweet body. A long and exhaustive series of laboratory experiments, extending through several years, were necessary for the satisfactory development of the chemical process of production. What saccharine really is can best be answered by Dr. Fahlberg himself. In a paper read before the British Association at Manchester in 1887 he defines saccharine as—

"An inner anhydride of orthosulphamine-benzoic acid, which yields salts and ethers entirely different from the orthosulphamine-benzoic acid; in fact, I have succeeded in transforming one into the other, and *vice versa*. If orthosulphamine-benzoic acid be heated, it changes into saccharine with the elimination of water; if, on the other hand, saccharine be subjected to a current of hydrochloric acid gas in the presence of alcohol, the ether of orthosulphamine-benzoic acid is formed, which also yields, on heating, saccharine, with the exception that in this case not water, but alcohol is eliminated."

As might be expected, a discovery of such practical utility had to run the gauntlet of much hostile criticism. It formed a fruitful subject for discussion in various scientific societies and journals. Attempts were made to show that it was not only deleterious, but dangerous. It is only fair to say, however, that these arguments seem to have been successfully controverted. An overwhelming mass of expert testimony is recorded in favor of saccharine. Eminent professors like Sir H. E. Roscoe, in London; Leyden, in Berlin; Paul, in Paris; Von Barth, in Vienna, and a host of others, after thorough tests, have certified that the effects of saccharine upon the physical and psychical functions of the brute and human systems are entirely harmless.

Saccharine in its pure condition is a white powder. Various exclusive advantages are claimed for its use in the arts, household and medicine. To enumerate a few: It is so small in bulk that the saving in storage and freight is, of course, very great; its valuable antiseptic qualities make it especially available in preserving, as well as sweetening, articles of food, such as jellies, fruits, etc.; its non fermentable character. In the distilling of brandies and liquors and in the brewing of beer saccharine has been used with signal success. Mixed with glucose, saccharine has a sweetness equal to the finest refined sugar. Further, saccharine serves a distinctly medical purpose. It is employed to disguise the unpleasant taste of medicine and in the preparation of medicated wines and other cordials. It has also been highly indorsed as a substitute for sugar for those suffering from diabetes and from fatness. Unlike sugar, it does not go to form surplus nourishment. Finally, it may be added that this highly concentrated sweetening substance requires only a little intelligence to be successfully used in the household.

Saccharine should never be taken in a pure state. Some idea of its power will be conveyed when it is understood that one part of it will give a very sweet taste to ten thousand parts of water. Tasted in too large a quantity, as Dr. Fahlberg observes, it acts upon the nerves in such a way as to paralyze the sense of taste, just as powerful music stuns or deadens the auditory nerves, or a bright light acts upon the optic nerves.

Dr. Fahlberg has, in connection with his partners, devoted himself of late years to the placing of this commodity on the market in practical form. It is manufactured and put up in three ways, viz., pure

saccharine powder, easily soluble saccharine in gravel form, and saccharine tablets. The latter two preparations contain a small percentage of bicarbonate of soda and are more available for cooking purposes.

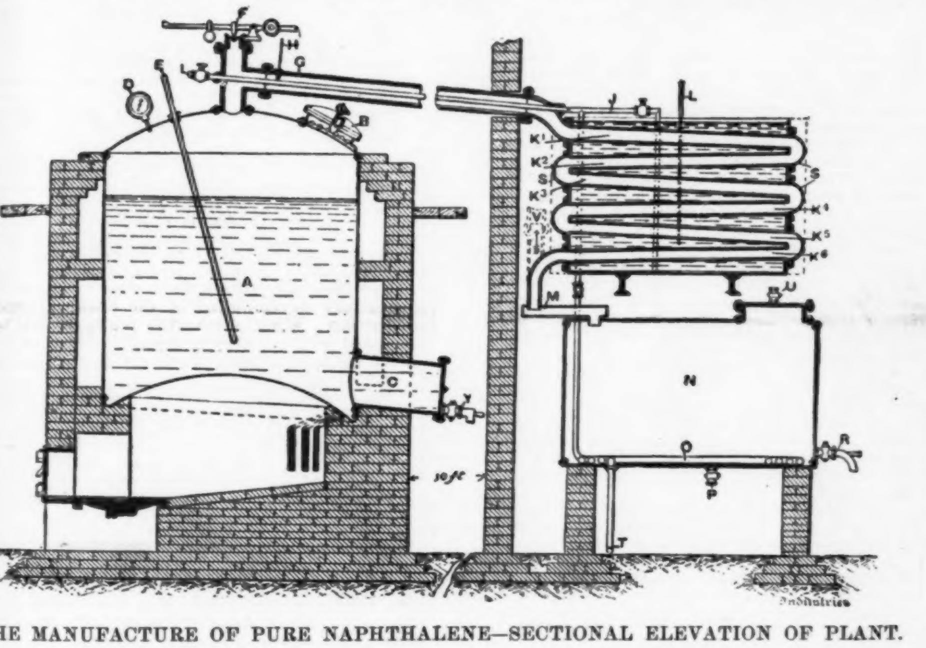
The factory—and, so far as I am informed, it is the only one of its kind existing—is at Salbke-Westerhusen, on the Elbe.

Patents have been obtained in most civilized lands, and monopolies of sale (which debar the manufacturers from selling direct) exist in many countries, including the United States. The American agents are J. Movius & Son, New York. Up to the present, however, the American trade has been inconsequential. In 1891, the export to New York was only about 800 kilogrammes (1,800 pounds approximately), while during the same period 7,200 kilogrammes was shipped to England. I understand that the owners would erect a factory in the United States should the state of the trade ever warrant it. ALBERT H. WASHBURN,
United States Commercial Agent.

Magdeburg, September, 1892.

THE MANUFACTURE OF PURE NAPHTHALENE.

NAPHTHALENE was for many years a source of serious trouble to gas managers, and is so to some extent even to-day. It has, however, of late years taken an important place in technical chemistry as the starting point of a series of coloring matters of great importance in the tinctorial industries. It is not that naphthalene is itself capable of yielding colors by any simple, direct treatment, but because—in a manner similar to benzene in the manufacture of aniline—the naphthalene is first converted into a nitro-compound—nitro-naphthalene, which is then reduced to the amine naphthylamine, by the action of nascent hydrogen; or, again, by "sulphonation"—*i. e.*, the action of sulphuric acid of a specific gravity not less than 1·85, whereby naphthalene is converted into alpha-naphthalene-disulphonic acid, which by fusion in a special manner with caustic soda produces the naphthols. It is, therefore, by the preliminary processes of converting naphthalene into substances bearing such formidable titles as alpha-naphthylamine, beta-naphthylamine, alpha-naphthol, beta-naphthol, mono and tri-sulphonic acids of beta-naphthol, and other polysyllabic substances, that the more immediate color-producing operations are reached.



THE MANUFACTURE OF PURE NAPHTHALENE—SECTIONAL ELEVATION OF PLANT.

As will be inferred from the great variety of colors produced, and the great delicacy of the shades, purity in the raw materials used is a *sine qua non*. It is, therefore, at the very outset of prime importance that the naphthalene, the radical of the industry, should be of the highest commercial purity, and it is found in practice that a product having a melting point of 79·5° C., which only shows slight discoloration when dissolved in excess of strong sulphuric acid, and is free from the slightest trace of tar oils, is necessary to secure good results.

The manufacture of this article is conducted as follows: The crude naphthalene which crystallizes from the heavy oils in the fractionation of coal tar is subjected to distillation in the apparatus shown in sectional elevation herewith. In this plant A represents the body of a still, 7 ft. in diameter and 7 ft. deep, with a dished bottom having an inclination toward the mudhole, C, so that the still can be as nearly as possible emptied by a 2 in. tap Y shown in the mudhole cover. The still is provided with a manhole cover of the improved self-locking type, as used on gas retorts, by which rapidity of closing and opening and a tight joint are secured. A delicate pressure gauge, D, and an iron tube or "pocket" to carry the thermometer, E, are also fitted in the top of the still as shown. The still is fitted with a safety valve, F, which is set to blow off at a very slight pressure. The vapor passes from the still head, by the 6 in. pipe, G, to the condensing worm, K.

This pipe, G, has a ½ in. steam pipe, I J, passing down its center, fitted with valves at I and J, and terminating in the cooling water which surrounds the worm, K. A small thermometer, H, is inserted in a pocket at G, and serves as a check to the indications of the thermometer, E, in the still itself. To minimize damage in case of fire, the still and its brick setting are erected under light shedding some 10 ft. or more clear of the building where the condensation takes place, and the pipe, G, is consequently exposed to atmospheric thermal changes, which would cause the naphthalene to solidify; it is therefore best to cover it with non-conducting composition to prevent blocking. The worm, K, may, of course, be a coil-shaped one, or of any of the forms in vogue in other distilling processes. The illustration shows a form which is in use in America, in which the vapors take a zigzag direction along the pipes, K. These pipes are cast, or made sound with borings to the ends of the water tank, thus avoiding internal joints and bringing leakages to the outside, facilitating inspection and repair. The ends of the pipes, K_1 and K_2, are joined by cast iron caps, S, fastened on with set screws, and the remaining pipes are similarly joined, thus making a complete worm with all joints outside.

To prevent the exposed ends, S S, becoming too cool and thus being blocked with naphthalene, a sheet iron casing is fastened in the position shown by the dotted lines, and the intervening space filled with sand or iron borings. A thermometer, L, is immersed in the cooling water. The condensed liquid flows down the shoot, M, into a cylindrical receiver, N, provided with a manhole and escape tap, U, a run-off tap, R, a sludge tap, P, fitted flush with the bottom for cleaning purposes, and a steam coil, O, by which the contents are maintained in a liquid condition. This receiver is 7 ft. in diameter and 4 ft. deep. In some cases horizontal cylindrical tanks are used, but they are not so convenient, and in stock taking their contents are not so readily ascertained by direct gauging. The crude naphthalene is charged into the still through the manhole, B, and a small fire is put under the still to liquefy the charge. The still is filled so that the liquid contents reach to the level shown or thereabout, thus leaving boiler room. This would correspond to over five tons of crude naphthalene. A quantity of caustic soda solution at 70° Twaddell corresponding to about 30 lb. of 70 per cent. caustic soda is added, and the distillation proceeded with. Care is taken that the safety valve, F, is in good order, the pockets, F and H, are filled with oil to insure the thermometers responding promptly to varying temperatures, and steam is passed through the pipe, I J, to prevent solidification of naphthalene and consequent blocking, the steam being conducted into the water which surrounds the worm, K, so as to maintain a temperature of 80°, and steam is passed through the coil, O. The first runnings consist of water and oily matters, with a little naphthalene, the latter commencing to come over at 210°, and the former gradually ceasing as the distillation proceeds. The stillman takes small samples at the worm end from time to time, and as soon as the aqueous matters have ceased, the condensed products, which up to this time have been run into a receptacle not shown in the illustration, are led by the shoot, M, into the receiver, N, and the distillation carried on until a temperature of 235° is reached, when the distillation finishes and the fire is drawn. The liquid naphthalene is thickened to the consistency of bricklayers' mortar by mixing with ground naphthalene residues from previous operations. The pasty mass is transferred to strong bags and pressed while hot by hydraulic pressure up to three tons per square inch—a well known operation needing no special description. The oily matters are thus expressed, collected, and sometimes used as liquid fuel, and the naphthalene is left as a hard, somewhat gray cake, which, when struck, should give a good ringing sound. This is known as "pressed material," and each lot is carefully tested in the laboratory before further treatment.

A second distilling apparatus, similar to and in close proximity to the first still, is charged with the pressed material together with about 1 cwt. of "best thirds" commercial sulphur, fire is applied and the distillation conducted as above described. The "first runnings" are kept separate, and together with those from other distillations, worked up with fresh crude material. The same observations as to temperature apply in this distillation as in the former one. In this case, however, a considerable quantity of sulphureted hydrogen gas is evolved, and this is drawn off at the end of the worm through the pipe shown by the dotted lines at V into a box fitted with wire gauze "baffles," or similar means which arrest the naphthalene unavoidably accompanying the gas. The sulphureted hydrogen passes thence to the chimney or to an oxide of iron absorber. The naphthalene collects in a receiver similar to N, and is maintained in a liquid condition until the following morning, when it is forced by compressed air or "blown over" into a third still in all respects similar to that shown. Here a quantity of 70° Twaddell caustic soda solution corresponding to about 50 lb. of solid 70 per cent. caustic soda is added, and the naphthalene distilled as before. In this distillation the caustic soda reacts at a temperature less than 160°, and to prevent the reaction reversing itself at a higher temperature, the fire is drawn as soon as the thermometer, E, shows 165° to 170°, and the contents of the still are allowed to settle for one hour, at the end of which time the caustic soda and the fixed impurities are drawn off by opening the 2 in. tap Y in the lid of the mudhole C. The tap is then closed and the distillation proceeded with as in the previous cases, separating "first runnings" and finishing at 235° C. The finished naphthalene in the receiver, N, is run off into galvanized iron cans, which hold 100 lb. each; these are allowed to stand all night to solidify, and when emptied and the lumps broken on the following day, the result is a beautifully white crystalline product—naphthalene of the highest commercial purity, melting point 79·2° to 79·5° C., free from oily matters and suitable for the preparation of naphthylamines, naphthols, and tinctorial products.—*Industries.*

THE CONSTITUTION OF THE ALKALOIDS.*

By ALFRED R. L. DOHME.

DURING the centuries that disease has been combated by drugs and medicines, no person, be he doctor, alchemist, or chemist, until the beginning of the nineteenth century, had any idea as to what the efficacy of any given drug was due. It was at the time when chemistry was receiving its first rays of enlightening sunshine, cast upon it from the scrutinizing and farseeing brains of a Lavoisier, a Dalton, and a Berzelius; when it was still germinating in the dark confines of a chaotic earth, but just prepared to burst its enveloping shell and blossom into that beautiful and attractive hardy plant, *scientia chemiæ*. It was in 1806 that the German pharmacist, Serturner, isolated from opium morphine and meconic acid. No one attached any importance to the discovery, and it was not until in 1817 his investigations were republished under the title, "Morphine a New Vegetable Base and Meconic Acid, the Principal Constituents of Opium," that public attention was aroused. Serturner pointed out the decided alkaline properties of morphine, characterizing it definitely as a vegetable base very much resembling ammonia. The idea dawned upon the minds of chemists that perhaps other drugs might contain similar bases, and they went to work to test the truth of their surmise. The result was that many such bases were soon isolated, and between the years 1817 and 1835 no less than twenty-five new alkaloids sprang into existence, and in the following order:

1806, morphine, by Serturner; 1817, narcotine, by Robiquet; 1818, veratrine, by Meissner; 1818, strychnine, by Pelletier and Caventou; 1819, brucine, by Pelletier and Caventou; 1819, piperine, by Oersted; 1819, delphinine, by Brandes; 1820, cinchonine, by Pelletier and Caventou; 1820, quinine, by Pelletier and Caventou; 1820, solanine, by Desfosses; 1824, chelidonine, by Godefrey; 1826, corydaline, by Wackenroder; 1826, berberine, by Chevallier and Pelletan; 1827, conicine, by Giesecke; 1828, nicotine, by Posselt and Reimann; 1829, aricine, by Pelletier and Corriol; 1829, sanguinarine, by Dana; 1832, codeine, by Robiquet; 1832, narceine, by Pelletier; 1833, quinidine, by Henry and Delondre; 1833, atropine, by Geiger and Hesse; 1833, hyoscyamine, by Geiger and Hesse; 1833, aconitine, by Geiger and Hesse; 1833, colchicine, by Geiger and Hesse; 1835, pseudomorphine, by Pelletier and Thiboumery; 1835, thebaine, by Pelletier and Thiboumery, etc.

These alkaloids were, in most cases, analyzed by Liebig, Gerhardt, Laurent, and Regnault, and their empirical formulas given, as in the case of morphine, $C_{17}H_{19}NO_3$, etc.

As in the case of nearly every chemical compound during this early period of chemistry, only the composition was determined, no one troubling himself much about the constitution of compounds. In a short time, however, the fertile brain of Berzelius evolved a theory of the constitution of chemical compounds based upon the electrical conditions and properties of the various elements, generally known as the electro-chemical theory. Other theories followed soon after, accompanied, each and every one of them, by a long and often lively discussion in the journals of the time. Most of these compounds were, however, inorganic, while some of the simpler organic compounds also were considered. No one, however, made an onslaught on the numerous classes of alkaloids, despite their value, importance, and apparent similarity in composition. This is quite natural if we consider that fundamental questions of the constitution of compounds had first to be settled—a firm basis had first to be established before such complex bodies as alkaloids could be attacked. As a result, the simpler bodies, such as alcohol, benzene, ether, chloroform, aniline, etc., were first studied thoroughly and their mutual relation established. Berzelius explained alkaloids as compounds containing ammonia united to an indifferent group, while Liebig explained them by saying they were amidogen compounds, *i. e.*, compounds containing amidogen, NH_2, united to another radical, which latter varied, then, for the various alkaloids; or, in other words, they were all derived from ammonia by having an atom of the latter substituted by some other radical. The first great step in advance in this chapter of the alkaloids was taken in 1848, when Hofmann, the late lamented professor of chemistry in the University of Berlin, in Germany, and Wurtz, in Paris, by their brilliant work upon the substituted ammonias, showed that the latter were all derived from ammonia by the substitution in the latter of the hydrogen atoms by various radicals. They showed conclusively that the three hydrogen atoms of ammonia are all capable of being substituted by other elements and radicals, and that they all bear the same relation to the nitrogen atom. Besides this, they showed the distinction between primary, secondary, and tertiary amines, and especially the fact that all alkaloids were tertiary amines.

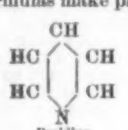
In 1846, Anderson, an English chemist, had obtained as a product of the dry distillation of bones an oil which he termed bone oil, containing a number of sub-

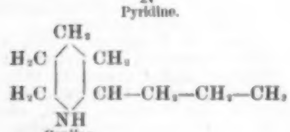
* From the *Pharmaceutical Review*, November.

stances, mostly of a basic character. From this bone oil he isolated, in particular, a basic substance having the formula C_5H_5N, to which he gave the name of pyridine. Some years previously Runge discovered in coal tar, by subjecting it similarly to dry distillation, a base which he named quinoline, and of which he found the formula to be C_9H_7N, but whose relation to pyridine was not discovered until later. Gerhardt had already, in 1842, obtained quinoline as a product of the distillation of strychnine, cinchonine, and quinine with alkalies.

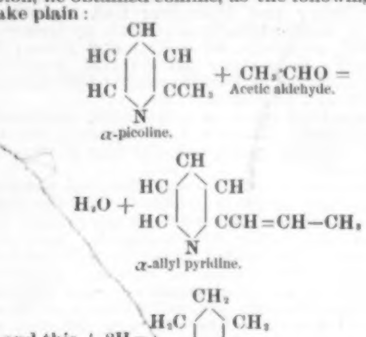
Later on it was found that the same quinoline is obtained when morphine, berberine, and brucine are similarly treated. From this time the intimate relation of nearly all alkaloids with quinoline or pyridine becomes more and more apparent, and chemists began to think that alkaloids were derivatives of these two hydrocarbons. Even the product of oxidation of alkaloids, usually acids, when distilled with lime or when simply heated yielded pyridine or quinoline. In order to verify or disprove the theory that alkaloids are derivatives of pyridine, chemists now applied the principles of synthesis, and by starting with pyridine strove to build up alkaloids. It is not many years ago that this work was done, and that artificial alkaloids, notably coniine, atropine, and piperidine, were made and found to be identical in every way with the naturally occurring alkaloids.

The German chemist Ladenburg, now professor at the University of Breslau, has become especially prominent in this chapter of chemistry, and his successful syntheses of alkaloids well merited the universal admiration they received. It was, of course, necessary to determine exactly the constitution of the alkaloid in question before any successful attempt to make it could be made. For simplicity sake, let us take the case of the first artificially prepared alkaloid, and trace up as closely as possible just how the work was done. The alkaloid is coniine. Hofmann had, in 1884, elucidated the constitution of coniine after a long series of investigations, resulting in the formation of hosts of new compounds, whole classes of them, such as the conyrines, the coniceines, etc. He showed that coniine was α-propyl piperidine—which, since piperidine was known to be hexahydropyridine, means that coniine is α-propyl-hexahydropyridine, which the two following formulas make plain:


Pyridine.


Coniine.

Starting with α-picoline, which is α*-methyl pyridine, he treated this with acetic aldehyde ($CH_3 CHO$.), and thus formed α-allyl pyridine. On reducing this by means of hydrogen generated by the action of metallic sodium on alcohol containing the α-allyl pyridine in solution, he obtained coniine, as the following equations make plain:



This product was identical with natural coniine in every way, save that it was optically inactive, *i. e.*, did not turn the plane of polarized light when the latter was passed through it. Ladenburg now converted his optically inactive coniine into optically active coniine by taking advantage of the well known fact that the mixture in equal parts of the dextro-rotatory and lævo-rotatory compounds produces optically inactive compounds. The problem then resolved itself into the splitting of the inactive coniine into dextro and lævo-rotatory coniine. This he did by making a coniine dextro-tartrate, *i. e.*, combining coniine with dextro-rotatory tartaric acid. On carefully and fractionally recrystallizing his salt he obtained two coniine tartrates of different solubility, which he separated. From these he obtained two coniines, one of which was dextro-rotatory coniine, and the other lævo-rotatory coniine. Thus we see how, starting with pyridine, Ladenburg obtained a coniine identical in every respect with natural coniine. This was the beginning of the alkaloid era, the era in which we now are, and the era which has already given us the constitution of nicotine, trigonelline, atropine, cocaine, pilocarpine, papaverine, narcotine, cotarnine, hydrastine, and berberine. Nicotine was attacked and its constitution elucidated by Cahours and Etard,† and that of trigonelline was similarly elucidated by Jahns‡ and Hantzsch.§

The constitution of atropine we owe to Ladenburg,‖ while Einhorn* showed that cocaine was methyl-benzoyl-ecgonine, and that ecgonine was methyl-tetrahydropyridyl-β-oxypropionic acid. The constitution of pilocarpine we owe to Hardy and Calmels,† that of papaverine to Goldschmidt,‡ and that of narcotine to Wegscheider.§ Hydrastine, the so-called white alkaloid of *Hydrastis canadensis*, owes its formula to the excellent work of Freund,‖ and finally berberine, its sister alkaloid, is indebted for its existence as a definitely known compound to W. H. Perkin, Jr.,¶ the young English chemist who has but recently been elected professor of chemistry at Manchester University to succeed the late Professor Schorlemmer. In a later article I propose to trace in detail as far as that is possible the work of Dr. Martin Freund on hydrastine, in order to show exactly how the problem of the determination of the constitution of alkaloids is attacked and successfully finished.

* The α, β, γ, etc., refer to the position of the substituting group with reference to the nitrogen atom; α is the position next to it, β second from it, and γ opposite to it.

† Cahours and Etard, *Comptes Rendus*, '88–97.

‡ Jahns, *Berichte der Deutschen Chem. Gesell.*, xx., p. 2840.

§ Hantzsch, *Berichte der Deutschen Chem. Gesell.*, xix., p. 31.

‖ Ladenburg, *Berichte der Deutschen Chem. Gesell.*, xxii., p. 2583.

* Einhorn, *Berichte der Deutschen Chem. Gesell.*, xxii., pp. 399, 1495, and 2870.

† Hardy and Calmels, *Comptes Rendus*, 102, 103, 105.

‡ Goldschmidt, *Monatshefte fur Chemie*, 4–10.

§ Wegscheider, *Berichte*, xvi., p. 1255.

‖ Freund, *Berichte*, 22 and 23.

¶ Perkin, *Jour. Chem. Soc.*, 1890, p. 992.

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